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BIOSTATISTICAL ANALYSIS OF FACTORS INFLUENCING LACTATION PERFORMANCE OF RANGE COWS AND WEANING WEIGHTS OF THEIR CALVES

University — Université

UNIVERSITY OF ALBERTA

Degree for which thesis was presented — Grade pour lequel cette thèse fut présentée

M. Sc.

Year this degree conferred — Année d'obtention de ce grade

1981

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BIOSTATISTICAL ANALYSIS OF FACTORS INFLUENCING LACTATION PERFORMANCE OF RANGE COWS AND WEANING WEIGHTS OF THEIR CALVES

by

© SARAH LOUISE BUTSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

IN

ANIMAL GENETICS

DEPARTMENT OF ANIMAL SCIENCE

EDMONTON, ALBERTA

September, 1981

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YEAR THIS DEGREE GRANTED September, 1981

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled BIOSTATISTICAL ANALYSIS OF FACTORS INFLUENCING LACTATION PERFORMANCE OF RANGE COWS AND WEANING WEIGHTS OF THEIR CALVES submitted by SARAH LOUISE BUTSON in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in ANIMAL GENETICS.

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Date Oct 18/81

"Science must not be a selfish pleasure. Those who are so fortunate as to be able to pursue it should be the first to put their knowledge at the service of mankind"

Karl Marx
Economic and Philosophic Manuscripts of 1844

ABSTRACT

An investigation was carried out to examine trends in lactation performance and factors influencing milk traits and calf weaning weight among range beef cattle.

Cows representing four beef and dairy-beef breeds and lines from the University of Alberta beef herds ranging in age from 2 to 10 years of age were used in the study. June and September measurements of milk and constituent percentages were taken on 206 and 242 cows in 1976 and 1977 respectively.

Age and breed of dam, and age and sex of calf were recorded. Other variables examined were cow weight changes during gestation and lactation and birthweights, weaning weights and preweaning ADG of their calves.

Milk variables and calf weaning weights were the traits studied.

In Chapter I the lactation performance of the four breed groups of dams was examined. Results indicated that crossbred cows with dairy breed ancestry yielded more milk and were more persistent than a purebred traditional beef breed.

Trends between breeds for constituent percentage production were less noticeable although the dairy crossbreds tended to produce less butterfat% than the purebreds.

In Chapter II factors influencing milk and constituent yields were investigated using the multiple regression

technique in Chapter II. Stepwise regressions involving age and breed of dam accounted for between 34.0% and 44.0% of the variance in any of the milk or constituent yields.

Full and restricted regression models allowed the introduction of independent variables after adjusting for age and breed of dam effects. Calf preweaning ADG showed a high association with milk yield variables. Other factors such as calf birthweight and cow weight changes however did not account for a significant proportion of the variance in any one milk or constituent yield variable.

Because associations and correlations between milk yield and calf ADG were significant but only moderately high, all factors influencing weaning weights of range calves were examined in Chapter III. Regression analysis indicated that age and breed of dam effects accounted for an average of 47% of the variance in calf weaning weight. When age and breed of dam were not considered, milk or constituent yields accounted for approximately 40% of weaning weight variance. However, milk variables still accounted for up to 10% of the variance after accounting for the effects of age and breed of dam.

Calf birthweight and cow weight changes had minor effects on calf weaning weight.

As a significant proportion of the variance in weaning weight was accounted for by milk variables, which in turn are largely a reflection of the breed of dam, it was concluded that selection for increased lactation performance and the introduction of dairy breeds into the breeding program of a beef herd can effect meaningful increases in the weights of calves weaned.

ACKNOWLEDGEMENTS

The author wishes to express her gratitude to her advisor, Dr. R.T. Berg, Chairman of the Department of Animal Science and Professor of Animal Genetics, for placing the facilities of the department at her disposal, and for his guidance and insight during the course of the investigation and thesis preparation.

My appreciation is extended to Dr. R. T. Hardin, Professor of Poultry Genetics, for his patience in assisting with the statistical analyses involved in the experiment.

Dr. M. A. Price and Dr. M. Makarechian, Professors of Animal Science, offered valuable suggestions for interpretation of the material.

I am grateful for the assistance of Mr. Ray Weingardt, Mr. Allen Mehlenbacher, Ms. Delores Lam and Mr. Gavin Godby in use of the computer for analyzing the data and helping with production of the final text.

Mrs. Marion Peebles provided much encouragement and facilitated my analyses with her fastidious record-keeping of the data.

I am grateful to Ms. Jan Oldfield for the typing of tables.

The collection of milk data for the experiment was made possible with the help of Mr. Gary Minchau and co-workers at the University of Alberta Research Ranch in Kinsella.

Mr. L. McKnight provided the facilities of the Central Alberta Milk Testing Laboratory for analyses of the milk constituents.

This investigation was supported by a research grant from Agriculture Canada.

I am thankful for the many moments throughout the course of this study which were shared with friends and ideological co-thinkers who gave me support and energy.

For Michael, to whom I owe the completion of this work, whose patience and understanding gave me much encouragement in my writing.

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I. LACTATION PERFORMANCE OF RANGE BEEF AND DAIRY-BEEF COWS

A. INTRODUCTION

The effect of milk yield on preweaning growth response of range cattle has been reported extensively (Long, 1980). Studies have indicated that measurements of milk yield and milk constituents of beef cows may serve as useful predictors of calf growth (Gleddie and Berg, 1968; Bluntzer and Sims, 1976). However, few workers have examined differences in lactation performance among various breeds of beef and dairy-beef cattle. Gaskins and Anderson (1980) suggest that knowledge of beef lactation trends may provide information on changing energy requirements involved in both cropping and herd management decisions. Such comparisons may also be useful as predictors of variation between breeds in levels of total energy consumption by calves, which in turn possibly affect growth response of suckling calves.

Selection criteria in dairy programs have emphasized total milk volume and persistency rather than constituent percentage production (Schmidt, 1971). Based on the foregoing and the negative correlation that exists between milk yield and constituent percentages (Preston and Willis, 1974), it is expected that beef cows with dairy backgrounds may produce a lower percentage of total solids than traditional beef breeds.

As with dairy cattle, lifetime performance of beef cows is an important criterion of production, yet few experimental regimes with groups of various breeds have been maintained over several breeding seasons for observations (Richardson *et al.*, 1977). According to Bluntzer and Sims (1976) quantifying milk production could help to determine the most efficient types of cow-calf units for utilizing and converting range forage into high-protein human foods.

Some authors (Rutledge *et al.*, 1970) contend that milk quantity rather than quality is more important for beef calves. However, to date there is little information concerning the constituent percentage differences between breeds of range cattle.

The purpose of this study was to determine the levels of milk yield and milk constituent percentages and to examine the seasonal variation in lactation traits of four lines or breeds of range beef and dairy-beef cows. The inter-relationships of milk variables were also examined.

B. MATERIALS AND METHODS

The breeding plan and general management of the herd have been described in detail by Berg (1978). Cows for breeding purposes have been maintained on native shortgrass range throughout the year with supplementary feed provided during the winter. Generally the policy of winter feeding is to provide the minimum amount of energy consistent with reasonable herd health. A summary of the December to March winter feeding plan from 1963 to 1975 is provided by Berg (1975).

First-calf heifers were fed to gain a moderate amount of weight over winter (10 to 20 Kg) prior to calving. Older cows were fed to maintain their precalving weight during gestation. Heifers were first bred in July and August to calve as two-year olds. All cows and heifers two years of age and older failing to calve each year were culled. First-calf heifers calved in a semi-enclosed feedlot area while all other cows calved on open range. Calves were born in April and May and remained with their dams with no creep feed. Calves of cows used in this study were weaned in the first week of October, averaging 156 and 158 days of age in 1976 and 1977 respectively.

Winter temperatures from October to March for 1975 to 1976 averaged -6°c and -5°c respectively. The winter of 1976-1977 was relatively mild with 29 days below -18°c compared with 49 days in 1975-1976. Summer precipitation, measured from April to October, was similar for both years, averaging approximately 32.0 cm. However, in 1976 the heaviest rainfall was in June and July compared with early May in 1977. Pasture conditions were therefore slightly less favorable in 1977.

Experiments relating milk production and cow size to efficiency and growth rate were conducted from 1964 through 1966 at the University of Alberta Research Ranch in Kinsella, Alberta (Peschiera, 1966; Gleddie and Berg, 1968). Relationships between milk yields and calf weaning weight were also studied. The lactation performance of purebred

Herefords was compared with that of various breed crosses of Charolais, Angus and Galloway cows.

The cows were from the experimental beef herd at The University of Alberta Research Ranch in Kinsella, and represented Hereford (HE), Beef-Synthetic (SY), Dairy-Beef (DB) and Dairy-Synthetic (DS) breed groups. The HE group is a purebred population open to artificial insemination from superior industry bulls selected on the basis of performance or progeny tests. The SY population, established in 1960, is predominantly a composite of Charolais, Angus and Galloway breeding. The DB is a crossbred group resulting from mating HE and SY cows to purebred dairy breed bulls. The DS line was begun in 1967 and is a composite of approximately 30% Holstein, 30% Brown Swiss and the rest traditional beef breeds (Berg, 1975).

A milking experiment similar to the one conducted from 1964 to 1966 (Gleddie, 1968) was repeated in 1976 and 1977. Measurements of milk were taken over 4 days each in June and September at an average of 44 and 130 days in lactation. Data were recorded over a two-year period for June and September averages of daily yields of milk and constituent percentages of butterfat (BF), protein (PROT) and lactose (LACT) for 448 animals. Cow age and breed were also recorded.

The method of milking was similar to that outlined by Jeffery and Berg (1971) using oxytocin and teat tubes for manual removal of milk. No machine or hand milking was involved. Milking commenced at 7am immediately following separation of the cows and calves. Cows were restrained in a commercial stock squeeze and milk letdown was induced using an intrajugular injection of 20 International Units of oxytocin. Teat tubes were inserted into all quarters and milk flow began within 15 seconds following injection. No further oxytocin injections were administered as residual milk following a second injection in a trial sample of 30 cows was negligible. Cows exhibiting mastitis in any quarter were not milked. Six hours later the same procedure was repeated and the milk weighed.

The 6-hour milk yield was multiplied by the interval in minutes between the two milkings to estimate 24-hour milk yield assuming a constant rate of milk secretion. Samples from each cow were collected and 5 grams of Potassium Dichromate were added as a preservative. Samples were analyzed at the Alberta Provincial Central Milk Testing Laboratory for percent butterfat using an Infra-Red Milk Analyzer. Protein percent was determined using the Kjeldahl Method as outlined by Bradstreet (1965). Solids-not-fat (SNF) percent was determined using the Golding Bead Test outlined by Golding (1964). Lactose percent was then estimated by subtracting protein percent from SNF percent. Results for lactose percent may therefore be slightly higher than average values as the small proportion of ash content would be included in the calculations.

In 1976 the experiment involved a total of 206 cows consisting of 45 HE, 102 SY, 26 DB and 33 DS. In 1977 a total of 242 cows were involved comprising 58 HE, 123 SY, 33 DB and 28 DS. Although approximately two-thirds of the cows tested in 1977 had been included in the milking experiment the previous summer, for statistical analyses cows in one year were considered to be different from cows in the other year. Cows ranged in age from 2 to 10 years.

Owing to the large number of available SY cows, random selection was made in this line from lactating dams nursing their own calves while all available dams from the HE, DB and DS groups were used.

Statistical Analyses

Least squares analyses of covariance for unequal subclass numbers (Mehlenbacher, 1978) were computed with the effects of breed of dam, age of dam, breed x age of dam interaction and sex of calf as sources of variation, and age of calf as a covariate.

Levels for the main effects were:

1. Breed of dam (B) classified as HE, SY, DB and DS;
2. Age of dam (A) classified as 2, 3, 4 and mature (over 4 years of age);
3. Sex of calf (S) classified as male and female;
4. Calf age (CA), the covariate was recorded as days of age.

Least squares constants for A, B, A x B and S were computed and used to calculate least squares means for milk variable averages of June, September and overall averages of milk yield, BF%, PROT% and LACT% in the following model:

$$MVijkl = u + Ai + Bj + ABij + Sk + blXijkl + eijkl$$

where MVijkl = adjusted milk variable of the ith age of dam, jth breed of dam and kth sex of calf.

u = overall population mean for x=0.

Ai = effect of the ith age of dam.

Bj = effect of the jth breed of dam.

ABij = effect of the interaction of the ith age of dam and jth breed of dam.

Sk = effect of the kth sex of calf.

blXijkl = partial regression of the lth milk variable on the age of calf.

eijkl = random error.

Bonferroni's t-statistic as outlined by Kirk (1968) was used to test differences between individual means when significant differences were established by least squares analysis.

Phenotypic correlations were computed over all the data sets.

Measurement of Milk Yield Using Oxytocin

Studies involving measurements of lactation in range cattle are limited primarily because of technical difficulties involved in milk removal (Richardson *et al.*, 1977). Furthermore there exists some controversy as to whether milk taken from range cows provides a good estimate of either the expression of breed potential or individual dam capacity for milk production.

Several experiments have been conducted to determine the efficacy of using exogenous oxytocin to estimate milk yield or calf ingestion. Sibaja and Schmidt (1975) found that injection of oxytocin (40 U.S.P.) did not interfere with normal milk ejection. However, Schwulst *et al.*, (1966) noted that whereas oxytocin did not significantly affect milk composition, its consistent administration tended to result in higher milk consumption by the calf and an increase in total milk production from the second to fifth months of lactation. Whereas Thompson *et al.*, (1973) found that amounts of residual milk were highly variable among Holsteins in mid-lactation, Schwulst *et al.*, found that average residual milk declined from 15% of the total in the first 2 to 3 weeks to 6% of total yield at any given milking. These results are similar to the 9 to 10% residual milk following suckling in the first months of lactation with Herefords as observed by Bluntzer and Sims (1976) but differ with the 25% residual observed by Thompson *et al.*, (1973). These workers reported that a 20 I.U. dose of oxytocin was required in Holsteins in mid-lactation to release 75% of total milk contained. Hanjra *et al.*, (1977) noted that the differences in residual milk between 10 I.U. and 20 I.U. injections in lactating buffalo were not significant. Hanjra *et al.*, collected from 0.79 to 5.56 Kg per week of residual milk.

Hall (1971) reported that when oxytocin was injected every two weeks calves began taking all of the available milk by the 10th week. By the 16th, no residual milk was obtained. Hall suggested therefore that the maximum demand of the calf coincides with total milk decline. According to Sibaja and Schmidt (1975) it is generally accepted that administration of oxytocin in the first 5 weeks post-partum will not be a true measure of calf ingestion.

It is not clear whether the large variability in residual milk percentages of total milk is due to breed differences in hormone levels or due to differences in experimental methods. According to literature reviewed by Hart *et al.*, (1975), some authors found significantly higher levels of growth hormones and non-esterified fatty acids, but lower concentrations of prolactin, insulin and glucose in the circulation of dairy cows compared with beef cows. However, Cowie (1976) reported no significant differences in prolactin levels between Freisians and Hereford x Sussex throughout lactation.

In the present study, a small number of cows were given additional injections of oxytocin approximately 15 minutes after the completion of the initial milk letdown. Negligible amounts of milk were collected but were not weighed. It was assumed that milk extracted using the single 20 I.U. injection served as an approximation of the 6-hour milk yield of the dam.

It is likely in this experiment that June milk yields extracted at approximately 44 days of lactation will represent a smaller proportion of total milk contained but will be greater than the amount ingested by the calf. Although early yields may not correspond as directly to calf ingestion, they may reflect more accurately the inherent genetic potential of the milk yield capacity of the dam. However, by September at an average of 130 days, individual milk yields will more probably correspond to levels of calf ingestion.

C. RESULTS AND DISCUSSION

Average Milk Yields

Least square means and standard errors of average daily milk yields by breed and breed-age groups of dam are presented in Table I.1 for 1976 and 1977. The averages for 24-hour milk yields in 1976 and 1977 were respectively 6.9± 0.1 and 7.1± 0.1 Kg/day over all breed and age groups examined, ranging from 4.5±0.3 Kg/day for 2-year old HE dams in 1977 to 9.3±0.4 Kg/day for mature DS dams in 1976. The difference between the 1976 and 1977 yields was significant and may be attributed to variation in weather conditions. The 1976 data showed an unexpected low production for DB dams which was possibly biased by the low yield for the single mature DB observation.

Table I.1. Least squares means and standard errors of average daily milk yields by breed and breed-age groups of dam, Kinsella 1976-1977

		Milk yield (Kg/day)					
		1976			1977		
	Breed	No.	Mean	SE	No.	Mean	SE
Grand total	All	206	6.9	0.1	242	7.1**	0.1
	HE	45	5.7a	0.2	58	5.9a	0.2
	SY	102	6.9b	0.1	123	6.8b	0.1
	DB	26	6.8b	0.4	33	8.1c	0.4
	DS	33	7.9c	0.3	28	7.7c	0.3
Age of dam (years)							
2	All	75	6.2w	0.2	82	6.0w	0.2
	HE	11	5.1	0.4	19	4.5	0.3
	SY	36	6.2	0.2	35	5.8	0.2
	DB	15	6.4	0.3	20	6.9	0.5
	DS	13	7.1	0.3	8	6.7	0.5
3	All	36	6.6w	0.2	52	7.2x	0.2
	HE	7	5.5	0.5	7	6.2	0.5
	SY	15	6.5	0.3	30	6.7	0.2
	DB	8	7.7	0.4	6	8.3	0.5
	DS	6	6.6	0.5	9	7.8	0.4
4	All	20	7.5x	0.3	26	7.4x	0.3
	HE	5	6.0	0.6	7	6.3	0.5
	SY	10	7.1	0.4	14	7.4	0.4
	DB	2	8.4	0.9	3	8.2	0.7
	DS	3	8.7	0.7	2	7.6	0.9
Mature	All	75	7.1x	0.3	82	7.9x	0.2
	HE	22	6.5	0.3	25	6.5	0.3
	SY	41	8.0	0.2	44	7.5	0.2
	DB	1	4.7	1.2	4	8.9	0.7
	DS	11	9.3	0.4	9	8.7	0.4

** 1977 average daily milk yield significantly different from 1976 ($P<0.01$).

a,b,c = Least squares means of milk yield by breed of dam group within years with different alphabetic letters are significantly different ($P<0.01$).

w,x = Least squares means of milk yield by age of dam group within years with different alphabetic letters are significantly different ($P<0.01$).

Breed of Dam Differences

The average values for HE and SY of 5.8 and 6.9 Kg/day respectively are within the range reported by Gleddie and Berg (1968), Hall (1971) and Nicol (1976) for traditional beef breeds (Table I.2) but are higher than yields of Herefords noted by Kress and Anderson (1974).

Average daily milk yields for the two dairy groups were 6.8 and 8.0 Kg/day for DB and 7.9 and 7.7 Kg/day for DS in each year respectively. These values are considerably lower than the 14.0 and 19.0 Kg/day averages of commercial dairy cows including Jersey, Ayrshire, Holstein and Brown Swiss (Schmidt, 1971; Preston and Willis, 1974; Cerbulis and Farrell, 1975) (Table I.2).

Table I.3 presents the analyses of covariance of average daily milk yields with calf age as the covariate. The F values indicate that the effects of both breed and age of dam accounted for a significant ($P<0.01$) source of variation in average milk yield for both years, similar to results reported by Gaskins and Anderson (1980).

As illustrated in Figure I.1 the DS yielded more milk than other breeds in 1976. However, DS yields in 1977 were not significantly different from yields of DB cows (Table I.1). Although it is likely that the single low yield recorded for the DB mature dam in 1976 biased the breed average for the DB group, it is not clear whether the DB and DS have the same genetic potential for milk production. The breeding background of the DS (approximately one-third

Table I.2. Average daily milk yields: literature breed averages.

Breed	Ave. Milk Yield (Kg/day)		Source
	Ave. 305 - day lactation		
A. DAIRY			
Holstein	19.5		Cerbulis and Farrel, 1973
Brown Swiss	19.9		"
Milking Shorthorn	14.8		Schmidt, 1971
Jersey	11.5		"
B. BEEF	2-6 weeks	200-210 days	
Hereford	5.5	1.7	Kress and Anderson, 1974
Angus	6.1	2.5	Gleddie and Berg, 1968
Shorthorn	6.8	2.3	Notter, 1967
Angus x Hereford	7.4	4.7	Gaskins and Anderson, 1980
Charolais	7.4	3.4	"

Table I.3. Analyses of covariance of average daily milk yields, Kinsella 1976-1977.

Source	d.f. 1976	d.f. 1977	F TESTS: Average daily milk 1976	F TESTS: Average daily milk 1977
Age of dam	3	3	5.65**	17.08**
Breed of dam	3	3	15.90**	14.17**
Age x Breed	9	9	2.11*	0.31
Sex of calf	1	1	0.0	0.33
Age of calf	1	1	2.60	0.0
Error	188	224		
Total	205	241		

* Significant at P<0.05; ** Significant at P<0.01.

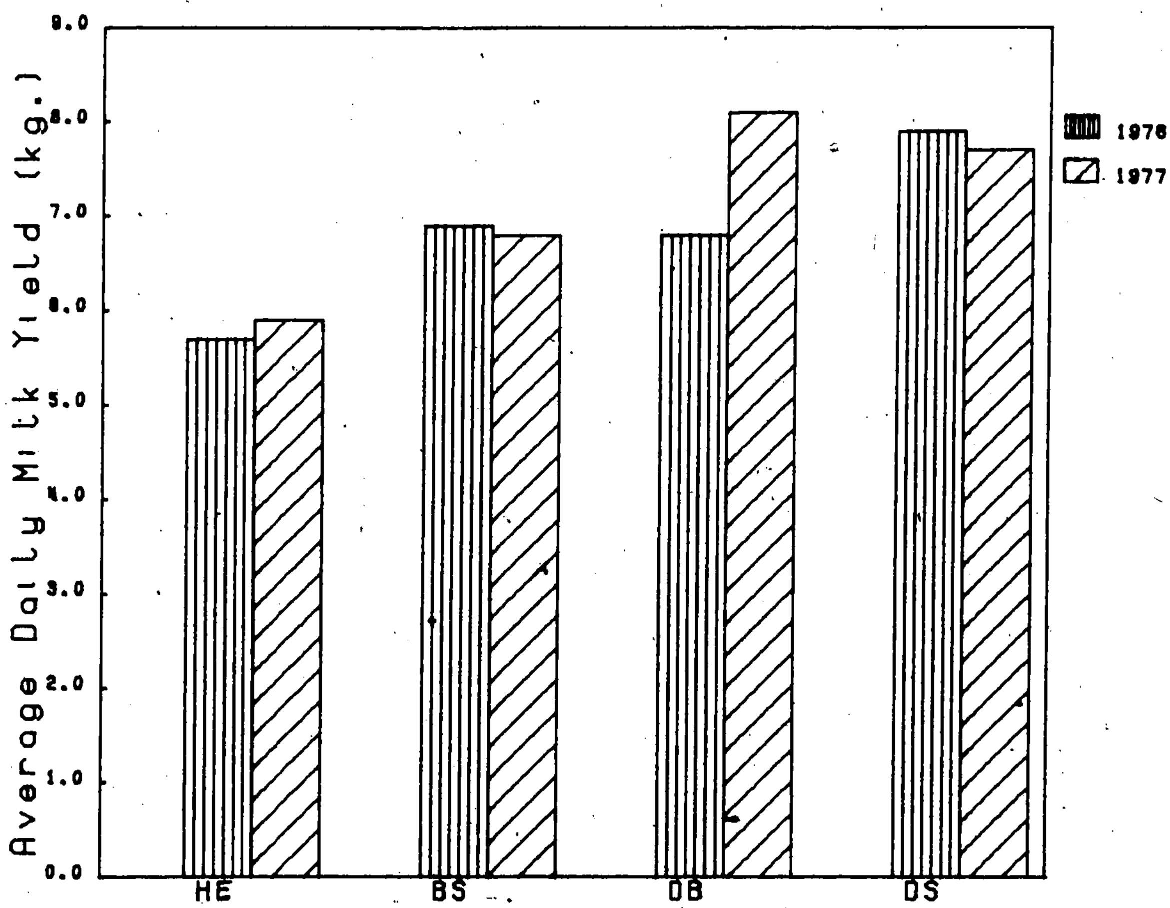

Figure I.1 Average milk yield by breed of dam, Kinsella 1976-1977

Holstein, one-third Brown Swiss and the remainder, traditional beef breeds), would suggest that calf suckling does not promote the full expression of the genetic potential of the dam.

Both the SY and DB groups produced approximately 1.0 and 1.5 Kg/day more than HE cows in 1976 and 1977 respectively, while the DS breed group yielded 2.2 and 1.8 Kg/day more than the HE respectively each year.

Results vary among reports. Marshall *et al.*, (1976) found that reciprocal crosses of Angus and Charolais cows milked less than Angus purebreds, while Hall (1971) and McGinty and Frerichs (1971) reported higher yields for Charolais and Brown Swiss-Hereford crossbreds than purebred Herefords respectively. Deutscher and Whiteman (1971) found that 2-year old Angus-Holstein crossbreds produced from 0.9 to 2.7 Kg more milk daily than purebred Angus cows. Similar breed differences were reported by Gleddie and Berg (1968), Wilson *et al.*, (1971), Rutledge *et al.*, (1971), Notter (1976) and Gaskins and Anderson (1980), suggesting that in general the average daily milk yield tends to increase with the proportion of dairy breeding. Cruikshank *et al.*, (1976) reported a 3-fold increase in the average annual income from the weaned calf and milk produced by various Friesian-beef crosses compared to purebred beef cows under range conditions.

It is not clear from results in this study whether differences in yields between the beef and dairy types are due to the specific contribution of the ancestral backgrounds of the DS (Holstein, Brown Swiss and other) or whether the higher yields for all the crossbreds are due to heterotic effects of crossbreeding.

Age of Dam Differences

Least squares means of average daily milk yield by age of dam groups (Table I.1) are illustrated in Figure I.2. Averaged over both years they were 6.1, 7.0, 7.5 and 7.5 Kg/day for all 2, 3, 4-year old and mature dams respectively. Yearly differences between 1976 and 1977 were significant only for the 3-year olds (P<0.01).

Mature dams tended to yield significantly (P<0.01) more than 2- and 3-year olds although differences between 4-year olds and mature cows were not significant in either year (Table I.1). In 1976 3-year olds yielded approximately 0.4 Kg/day more than 2-year olds; 4-year olds produced 0.9 Kg/day more than 3-year olds and 0.4 Kg/day more than mature cows. In 1977 however, 3-year olds produced 1.2 Kg/day more than 2-year olds and only 0.2 Kg less than the daily yield of 4-year olds. Mature cows produced an averaged of 0.5 Kg/day more than 4-year olds.

The 1977 results are more nearly similar to data in published material than to the 1976 results. Gaskins and Anderson (1980) noted that there was a positive linear trend (b=1.0 Kg/year) in daily milk production as age of cow increased from two to four years.

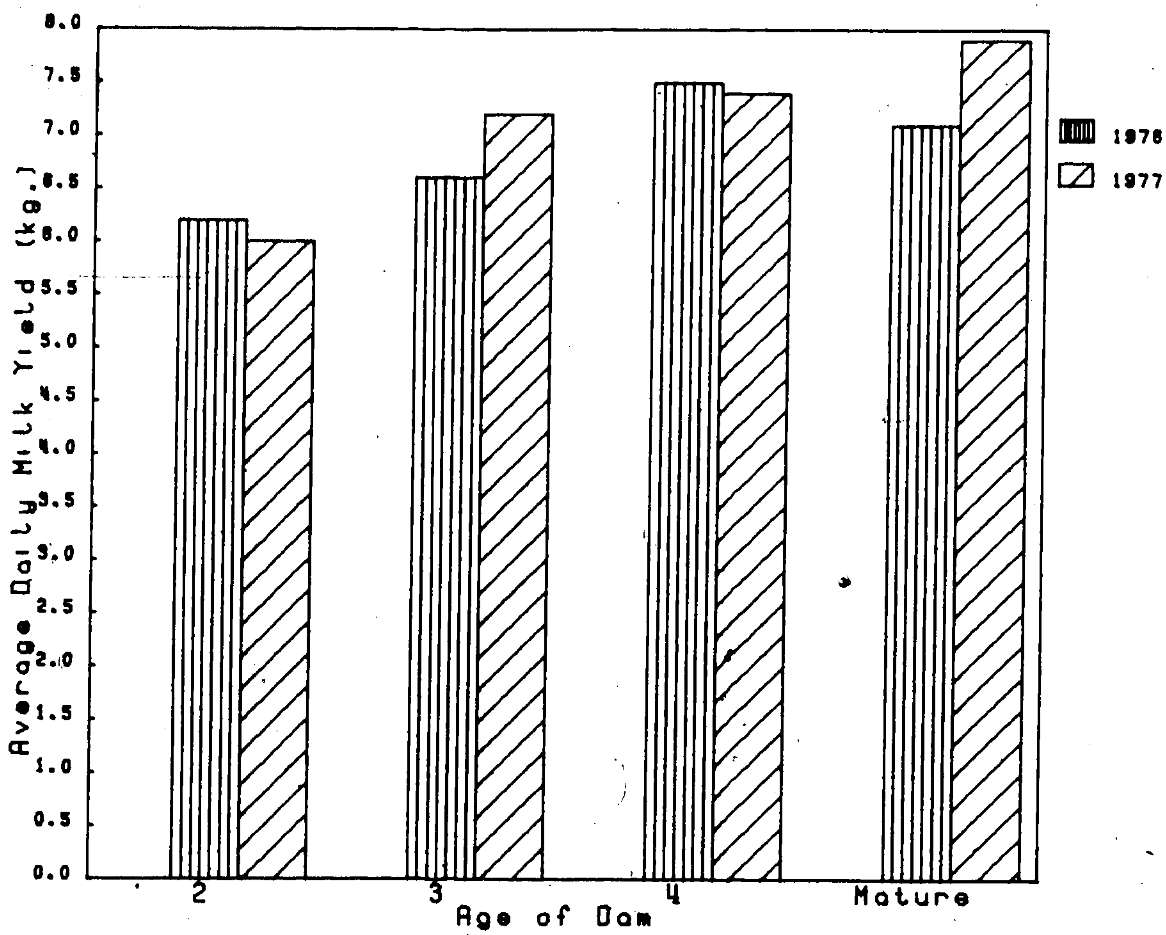

Figure I.2 Average milk yield by age of dam, Kinsella 1976-1977

Schmidt (1971) noted that for dairy cattle, more milk is produced with an increase in age due to the increased body weight including weight of the reproductive and digestive tract. Schmidt found that a 45.5 Kg increase in body weight was associated with an increase of 195.5 Kg total milk in a 310-day lactation. When body weight was held constant however, an increase in milk independent of body weight was expected until maturity. Ramirez and Porte (1976) reported a negative correlation between cow body weight and total milk yield, yet concluded that the first, second and third lactation number affected yield. Rutledge *et al.*, (1970, 1971) reported quadratic effects of age of dam on milk yield in Herefords with a maximum of 8.4 years, while Notter (1976) found that average milk yield for 4-year old Herefords was 25% greater than for 3-year olds.

Christensen *et al.*, (1973) found that age at first and second calving had more significant influences on yield than overall age effects alone. Neville *et al.*, (1974) suggested that although milk yield increased for cows up to six years of age before reaching a plateau, lactation number may influence milk production as much as age of dam at calving. However, it is possible that in studies by both Neville *et al.*, (1974) and Ramirez and Porte (1976), the lactation number is largely confounded by the age of dam effect.

Seasonal Variation in Milk Yields

Lactation curves for Holstein cows based on 305-day lactations (Schmidt, 1971) compared with those for various traditional beef breeds (Gleddie, 1968; Hall, 1971 and Gaskins and Anderson, 1980) are illustrated in Figure I.3. Milk yield for Holsteins peaks at about 3 to 6 weeks before remaining constant according to Schmidt (1971). Schmidt contends that pregnancy inhibits milk secretion by the 7th or 8th month of lactation when there is a sudden decline in milk. Ramirez and Porte (1976) and Wood (1972) found additional peaks corresponding to periods of flushes of grass growth or during periods of feeding silage when indoors, but the usual trend for dairy cattle is as outlined by Schmidt (1971).

It is generally thought that beef dams peak at about 4 weeks, but whether this is a breed difference between beef and dairy cows, confounded by the effect of calf suckling compared to regular machine milking, or simply due to differences in methods of measurement is not known. For example, Kress and Anderson (1974) found maximum production in 4- and 5-year old Herefords at 20 days (7.3 Kg/day) using the calf weigh-suckle-weigh method for measuring calf ingestion or milk production of the dam. However, Totusek *et al.*, (1973) found that when beef calves were weighed before and after suckling, the lactation curve for beef cows was more nearly similar to the dairy, peaking at 7 compared to 4 weeks with hand-milking. Neidhardt (1979) and Ramirez and Porte (1976) found a similar peak in the second month of lactation among Brahman and Hereford cows respectively on range in Chile and Venezuela using the weigh-suckle-weigh

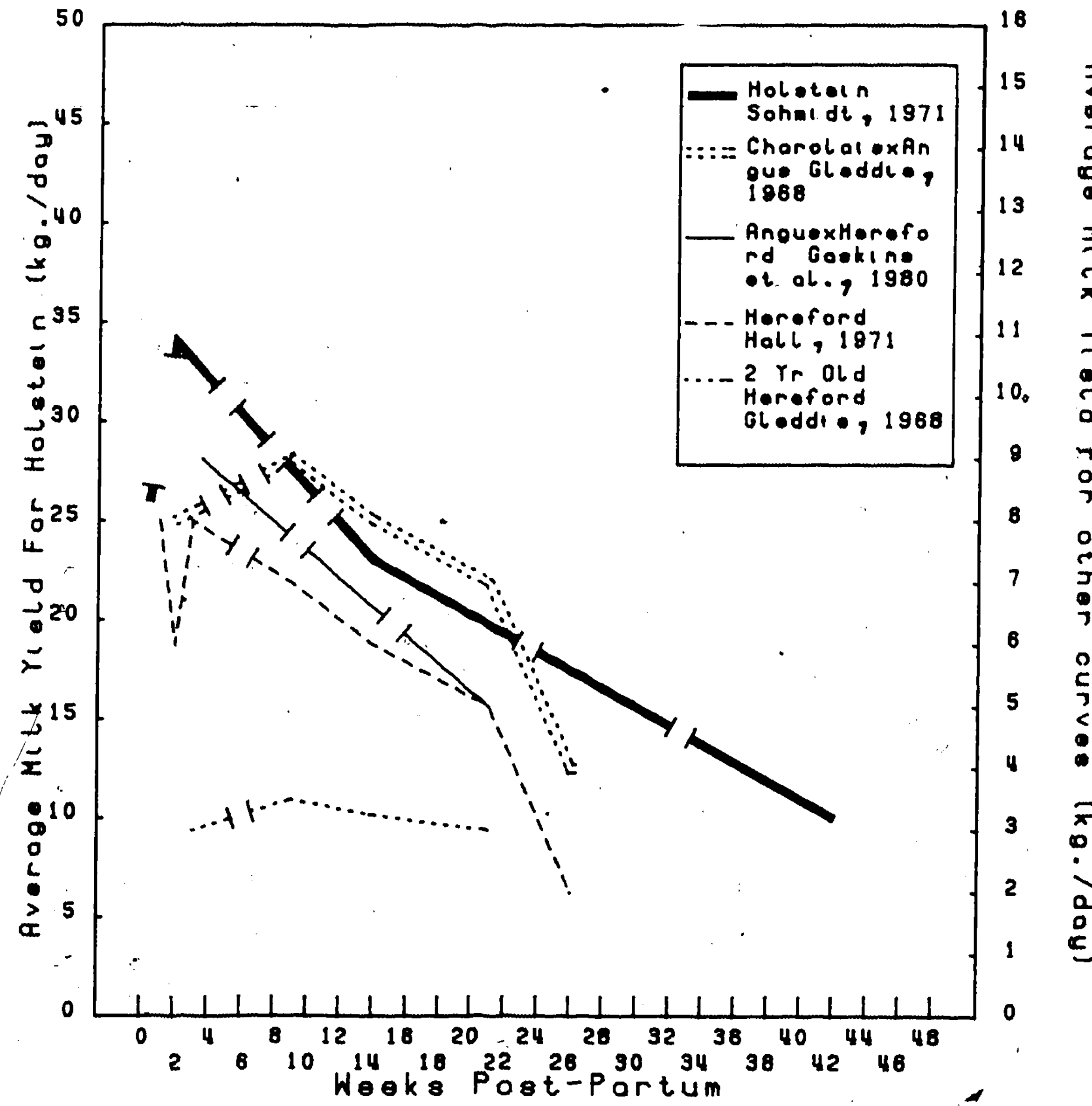

Figure I.3 Lactation curves of dairy and beef cows: literature breed averages method.

Based on the foregoing, it is possible that the method of measurement might shift the milk yield curve. Klett *et al.*, (1965) suggested that the range beef lactation curve is probably more flexible than that of dairy cows due to greater flexibility in milk production response to changing feed conditions. Deutscher and Whiteman (1971) observed that milk production curves of Angus-Holstein crossbreds on range paralleled range feed conditions.

Gleddie (1968) reported a decline in milk of various beef breeds from the first to fifth month (Figure I.3) which is different than dairy breeds with a rise from the first to the second month of lactation. He contended that the difference was due to the calf suckling effect. Hall (1971) noted a similar pattern, except that the Herefords he examined exhibited an initial high level which was lower than the maximum peak, followed by a sudden drop between 25 to 40 days, then a rapid decline (Figure I.3). Totusek *et al.*, (1973) suggested that variation in estimates of milk yield within the first 30 days post-partum of Hereford, Angus and Shorthorn cows was indicative of limited calf capacity, while greater variation later was due to individual cow differences in persistency.

It is clear that based on published reports, no specific trend for beef cow lactation curves has been established. Gaskins and Anderson (1980) noted that lactation curves measured for Jersey, Angus, Hereford and

Simmental crossbreds were generally curvilinear throughout lactation, but were more convex for cows which had higher milk production - (ie: the 3- and 4-year olds and the Jersey x Angus and Simmental x Angus cows) and were more linear for cows with lower milk production.

June and September Milk Yields

Analyses of covariance for average June and September milk yields are presented in Table I.4. The effect of breed of dam accounted for a highly significant (P<0.001) source of variance in June and September milk yields each year. This effect is illustrated in Figure I.4.

Tables I.5 and I.6 show the least squares means of June and September milk yield averages for each year by age and breed of dam. Between breeds, trends for June and September yields were similar to those for the overall average daily milk yields.

In 1976, June yields were significantly higher (P<0.01) for the DS line, averaging 1.9, 0.9 and 1.4 Kg/day more than HE, SY and DS groups respectively. In June of 1977 however, differences between the SY, DB and DS groups were not significant although these breeds yielded an average of 1.3 Kg/day more than HE dams.

September yields were significantly (P<0.01) lower than June yields each year for all breeds.

Dairy-Synthetic cows produced approximately 2.9, 1.1 and 0.9 Kg/day more in September than the HE, SY and DB cows respectively.

Table I.4. Analyses of covariance of average daily June and September milk yields, Kinsella 1976-1977.

Source	d.f.		June Milk (1)		September Milk (1)	
	1976	1977	1976	1977	1976	1977
Breed of dam	3	3	6.97***	4.31***	17.80***	30.18***
Age of dam	3	3	2.88*	10.09**	6.78**	29.41**
Age x Breed	9	9	1.35	1.39	2.81**	1.67
Sex of calf	1	1	0.17	0.23	0.24	0.58
Age of calf	1	1	1.07	0.86	2.95	3.87*
Error	188	224				
Total	205	241				

1: F values
* Significant at P<0.05, ** Significant at P<0.01, *** Significant at P<0.001.

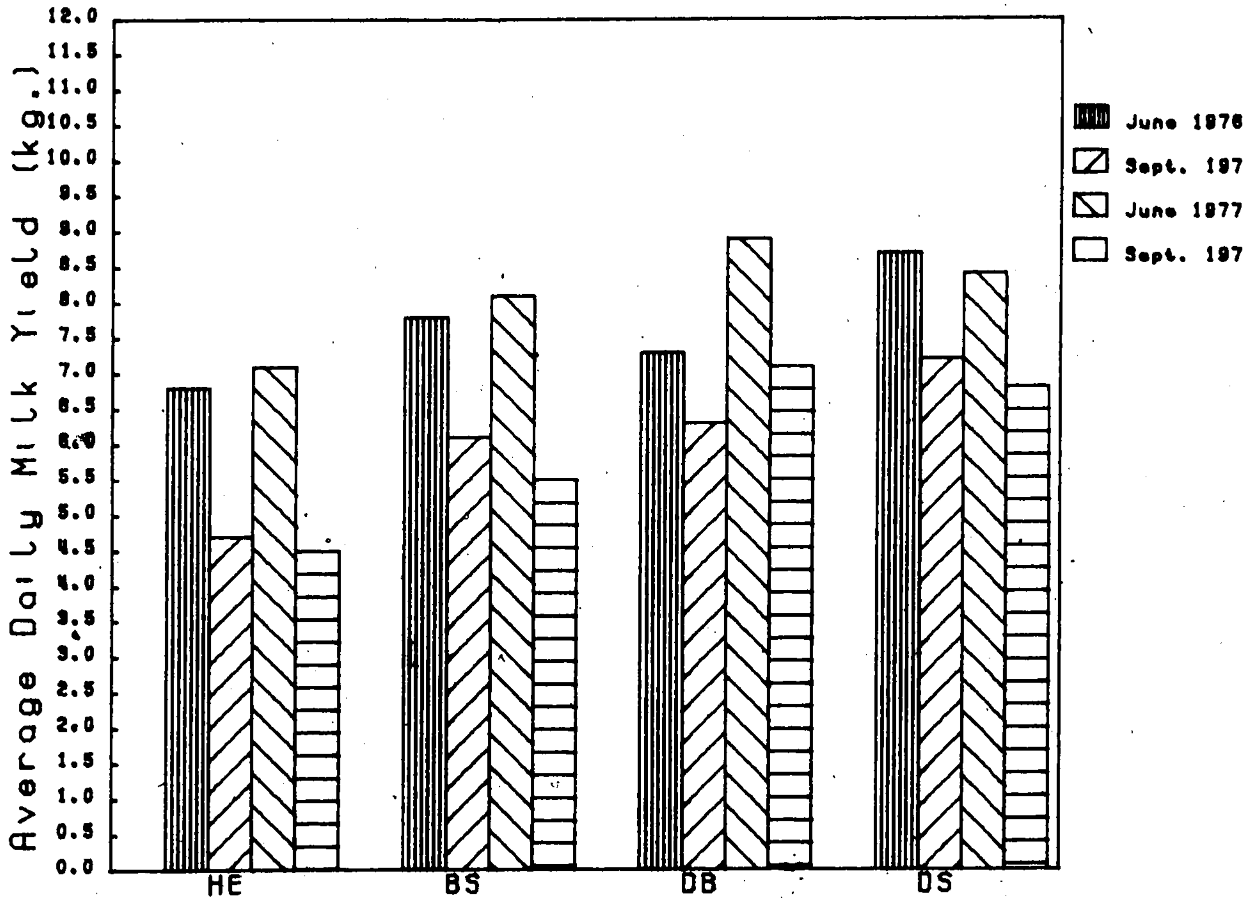

Figure I.4 June and September milk yields by breed of dam, Kinsella 1976-1977

Between ages, (Tables I.5 and I.6) mature dams tended to yield more than dams under 5 years of age in both milking periods, although differences were not always significant.

As measurements of milk variables were taken only in June and September, no lactation curves were extrapolated and prediction of trends was difficult. Figure I.4 illustrates the total differences between the two periods. The DB and DS dams demonstrated the highest persistency with total yields declining between 1.0 and 1.8 Kg between June and September. The HE dams were least persistent, averaging 2.5 Kg decreases each year between June and September.

Notter (1976) found significant breed differences between milk yields measured in beef cattle during all but the last month of lactation (176 days). In addition, the increase in persistency was inversely proportional to average milk yields measured from 121 to 176 days. This trend was noted for all but the low-yielding Charolais.

It is difficult to ascertain whether there are marked breed differences in lactation curve trends between beef and dairy types on range and if the differences in milk yields between HE and dairy types on range is always more noticeable at the end of the lactation. It is possible that the dairy-beef cows in this study were more persistent due to selection for 10-month lactations in their dairy breeding backgrounds, and because of greater stimulus due to the genotype of the calf.

Table I.5. Least squares means and standard errors of June and September average daily milk yields, Kinsella 1976.

			Milk yield (kg/day)				
			June		September		
	Breed	No.	Mean	SE	Mean	SE	Difference
Grand Total	All	206	7.6	0.2	6.1	0.1	1.5**
	HE	45	6.8a	0.3	4.3a	0.2	2.5**
	SY	102	7.8b	0.2	6.1b	0.2	1.7**
	DB	26	7.3b	0.5	6.3b	0.4	1.0**
	DS	33	8.7c	0.3	7.2c	0.3	1.5**
Age in years							
2	All	75	7.1x	0.2	5.3x	0.2	1.8**
	HE	11	6.1	0.5	4.1	0.4	2.0
	SY	36	7.2	0.3	5.2	0.2	2.0
	DB	15	7.2	0.4	5.6	0.3	1.6
	DS	13	7.9	0.5	6.4	0.4	1.5
3	All	36	7.2x	0.3	5.4x	0.2	1.8**
	HE	7	6.4	0.9	4.6	0.5	1.8
	SY	15	7.2	0.4	5.8	0.3	1.4
	DB	8	8.3	0.6	7.0	0.5	1.3
	DS	6	7.0	0.7	6.2	0.5	0.8
4	All	20	8.1y	0.4	7.0y	0.4	1.1*
	HE	5	7.0	0.7	4.9	0.6	2.1
	SY	10	8.2	0.5	5.9	0.4	2.3
	DB	2	7.5	1.1	9.3	0.9	-1.8
	DS	3	9.5	0.9	7.9	0.8	1.6
Mature	All	75	8.2y	0.4	6.0x	0.4	2.2**
	HE	22	7.7	0.3	5.3	0.3	2.4
	SY	41	8.7	0.3	7.3	0.2	1.4
	DB	1	6.1	1.6	3.2	1.3	2.9
	DS	11	10.4	0.5	8.3	0.4	2.1

** Significant at $P<0.01$.

a,b,c = Least squares means of milk yield by breed of dam within years with different alphabetic letters are significantly different ($P<0.01$).

x,y = Least squares means of milk yield by age of dam within years with different alphabetic letters are significantly different ($P<0.01$).

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Table I.6. Least squares means and standard errors of June and September average daily milk yields, Kinsella 1977.

	Breed	No.	Milk yields (kg/day) June Mean	June SE	September Mean	September SE	Difference
Grand Total	All	242	8.2	0.2	6.0	0.1	2.2**
	HE	58	7.2a	0.3	4.6a	0.2	2.6**
	SY	123	8.1b	0.2	5.6b	0.1	2.5**
	DB	33	8.8b	0.5	7.1c	0.3	1.7**
	DS	28	8.6b	0.4	6.8c	0.3	1.8**
Age in years							
2	All	82	6.9x	0.3	4.8x	0.1	2.1**
	HE	19	5.0	0.4	3.9	0.3	1.1**
	SY	35	6.8	0.3	4.6	0.2	2.2
	DB	20	7.6	0.6	5.4	0.3	2.2
	DS	8	8.3	0.7	5.1	0.4	3.2
3	All	52	8.6y	0.3	5.8y	0.2	2.8**
	HE	7	8.0	0.7	4.3	0.4	3.7
	SY	30	8.2	0.3	5.3	0.2	2.9
	DE	6	9.8	0.8	6.8	0.5	3.0
	DS	9	8.6	0.6	6.9	0.4	1.7
4	All	26	8.1y	0.5	6.6z	0.3	1.5**
	HE	7	7.5	0.7	5.0	0.4	2.5
	SY	14	8.8	0.5	6.0	0.3	2.8
	DB	3	8.5	0.1	7.9	0.7	0.6
	DS	2	7.8	1.3	7.9	0.8	-0.1
Mature	All	82	9.0y	0.3	6.8z	0.2	2.2**
	HE	25	8.2	0.4	4.9	0.2	3.3
	SY	44	8.6	0.3	6.4	0.2	2.2
	DB	4	9.6	0.9	8.2	0.6	1.4
	DS	9	9.6	0.6	7.9	0.4	1.7

** Significant at $P<0.01$

a,b,c = Least squares means of milk yield by breed of dam within years with different alphabetic letters are significantly different ($P<0.01$).

x,y,z = Least squares means of milk yield by age of dam within years with different alphabetic letters are significantly different ($P<0.01$).

Differences in persistency between beef and dairy types may also be due to the fact that the genetic potential of dairy cows is more clearly expressed because of the method of milk removal. The high and consistent demand placed on dairy cows for 305-day lactations as compared with the relatively nominal demand placed on beef cows suckling their calves may account for the differences in trends. The genetic potential of even the high-producing older dairy-beef crossbreds in this study was not fully expressed, as measured with respect to milk yields. It is possible that the drop in persistency for all nursing cows becomes more dependent upon the individual cows' responses to suckling, rather than strictly a reflection of breed.

Age of dam also accounted for a significant ($P<0.05$) source of variance in June and September milk yields (Table I.4). As shown in Tables I.5 and I.6, among age groups mature animals tended to yield more in both June and September than dams under 5 years of age, although differences were not always significant. The results in this study indicate no consistent pattern for persistency trends for dam's age among range beef cattle.

Constituent Percentages

Average constituent percentages for traditional dairy and beef breeds are shown in Table I.7. According to Schmidt (1971) although there is a large variation in composition between breeds of dairy cattle, lactose and mineral content are not as variable and are not affected noticeably by

Table I.7. Average constituent percentages for dairy and beef breeds: literature breed averages.

Constituent	Holstein[1]	Jersey[1]	Brown Swiss[1]	Milking Shorthorn[1]	Angus[2]	Hereford[2]	
Butterfat %	3.7 - 4.0	5.4	4.3	3.6	i) 3.9 - 4.4 ii) 6.7	i) 3.6 - 4.1 ii) 4.4 - 6.7	i) 3.4 ii) 6.3
Protein	3.1	4.1	3.8	3.2	i) 3.4 ii) 3.5	i) 3.4 ii) 3.5	i) -- ii) --
Lactose	4.9 - 5.0	5.0	5.2	4.8	--	--	--
Total Solids	12.9	--	--	--	i) 12.3 - 12.9 ii) 16.2	i) 12.5 ii) 16.5	i) 11.7 ii) 16.0

[1] Based on 305-day lactation (Schmidt, 1971; Cerbulis and Farrel, 1975).

[2] i) Based on 2 to 6 weeks post-partum, (Hall, 1971; Schwulst *et al*., 1966; Cundiff *et al*., 1974; Gleddie and Berg, 1968).
ii) Based on weaning averages at 200-210 days (above referen[illegible]).

selection for milk yield. Various reports however (Schmidt, 1971; Christensen *et al*., 1973 and Gaunt, 1973) note that butterfat, protein and solids-not-fat percentages decrease with an increase in milk yield due to a negative correlation between these components and milk yield.

Some workers (Gleddie, 1968 and Hall, 1971) report that beef cows tend to produce more total solids, but much of the data is incomplete.

Tables I.8, I.9 and I.10 present the least squares means and standard errors of average constituent percentages of BF, PROT and LACT for 1976 and 1977. The differences between years for each constituent percentage for all cows were significant ($P<0.05$).

Results are within the range reported in the literature for protein, but tend to be higher than the value for BF% and total solids reported by Neidhart *et al*., (1979).

Butterfat

The BF% tended to be greater in 1977 than in 1976; differences were not as large for PROT% and LACT% between years.

BF% exhibited a greater range than PROT or LACT%, from 4.05±0.42 for 4-year old DB cows in 1976 to 5.32±0.60% for the single mature cow in 1976. However, as the small sample size of mature DB animals resulted in large standard errors, the BF% range may be more accurately illustrated by the SY group, which exhibited a range of from 4.27±0.19% in 1976 to 5.3±0.30% in 1977.

Table I.8. Least squares means and standard errors of average butterfat percentages, Kinsella 1976-1977.

	Breed	No. of cows 1976	No. of cows 1977	Butterfat % 1976 Mean	Butterfat % 1976 S.E.	Butterfat % 1977 Mean	Butterfat % 1977 S.E.
Grand Total	All	206	242	4.62l	0.07	4.97m	0.07
	HE	45	58	4.75a	0.10	5.07a	0.10
	SY	102	123	4.53a	0.06	3.50a	0.04
	DB	26	33	4.64a	0.19	4.90a	0.19
	DS	33	28	4.57a	0.12	5.03a	0.13
Age in years							
2	All	75	82	4.47x	0.06	4.75xy	0.11
	HE	11	19	4.71	0.18	4.86	0.15
	SY	36	35	4.44	0.10	4.79	0.11
	DB	15	20	4.42	0.15	4.95	0.29
	DS	13	8	4.31	0.17	4.39	0.27
3	All	36	52	4.66x	0.11	5.01x	0.11
	HE	7	7	4.62	0.22	4.97	0.15
	SY	15	30	4.67	0.15	5.00	0.26
	DB	8	6	4.74	0.21	4.38	0.27
	DS	6	9	4.63	0.25	5.69	0.35
4	All	20	26	4.31x	0.16	5.26x	0.17
	HE	5	7	4.53	0.27	5.27	0.18
	SY	10	14	4.27	0.19	5.33	0.30
	DB	2	3	4.05	0.42	5.25	0.25
	DS	3	2	4.40	0.34	5.20	0.42
Mature	All	75	82	5.04y	0.16	4.86y	0.11
	HE	22	25	5.12	0.13	5.19	0.24
	SY	41	44	4.75	0.09	4.40	0.31
	DB	1	4	5.32	0.60	5.01	0.27
	DS	11	9	4.94	0.19	4.86	0.22

a - Least squares means of overall average BF% by breed of dam within each year with different alphabetic letters are significantly different (P<0.05)

l,m= Least squares means of overall average BF% forall cows with different alphabetic letters are significantly different (P<0.01)

x,y= Least squares means of overall average BF% by age of dam within each year with different alphabetic letters are significantly different (P<0.05)

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Table I.9. Least squares means and standard errors of average protein percentages, Kinsella 1976-1977.

	Breed	No. of cows 1976	No. of cows 1977	Protein % 1976 Mean	Protein % 1976 S.E.	Protein % 1977 Mean	Protein % 1977 S.E.
Grand Total	All	206	242	3.55l	0.04	3.34m	0.02
	HE	45	58	3.55a	0.06	3.48a	0.04
	SY	102	123	3.42a	0.02	3.58a	0.04
	DB	26	33	3.65a	0.11	3.42a	0.07
	DS	33	28	3.52a	0.07	3.45a	0.06
Age in years							
2 <n1>	All	75	82	3.64xy	0.04	3.50x	0.04
	HE	11	19	3.63	0.10	3.61	0.06
	SY	36	35	3.51	0.05	3.37	0.04
	DB	15	20	3.85	0.06	3.51	0.11
	DS	13	8	3.55	0.09	3.51	0.10
3	All	36	52	3.54x	0.06	3.49xy	0.04
	HE	7	7	3.52	0.12	3.51	0.05
	SY	15	30	3.50	0.06	3.55	0.10
	DB	8	6	3.58	0.12	3.35	0.10
	DS	6	9	3.54	0.14	3.53	0.14
4	All	20	26	3.42x	0.09	3.39xy	0.06
	HE	5	7	3.52	0.15	3.52	0.07
	SY	10	14	3.44	0.10	3.39	0.11
	DB	2	3	3.26	0.23	3.39	0.09
	DS	3	2	3.48	0.19	3.26	0.16
Mature	All	75	82	3.63y	0.09	3.39y	0.04
	HE	22	25	3.54	0.07	3.28	0.04
	SY	41	44	3.56	0.05	3.38	0.12
	DB	1	4	3.90	0.33	3.43	0.10
	DS	11	9	3.50	0.10	3.48	0.08

a = Least squares means of overall average PROT% by breed of dam within each year with different alphabetic letters are significantly different ($P<0.05$)

l,m= Least squares means of overall average PROT% for all cows with different alphabetic letters are significantly different ($P<0.01$)

x,y= Least squares means of overall average PROT% by age of dam within each year with different alphabetic letters are significantly different ($P<0.05$)

Table I.10. Least squares means and standard errors of average lactose percentages, Kinsella 1976-1977.

	Breed	No. of cows 1976	No. of cows 1977	Lactose % 1976 Mean	Lactose % 1976 S.E.	Lactose % 1977 Mean	Lactose % 1977 S.E.
Grand Total	All	206	242	5.49l	0.04	5.25m	0.03
	HE	45	58	5.59a	0.06	5.46a	0.05
	SY	102	123	5.58a	0.04	5.33b	0.03
	DB	26	33	5.35b	0.11	5.15c	0.08
	DS	33	28	5.42ab	0.07	5.04c	0.07
Age in years							
2	All	75	82	5.50x	0.05	5.29x	0.05
	HE	11	19	5.67	0.10	5.51	0.07
	SY	36	35	5.67	0.06	5.46	0.05
	DB	15	20	5.06	0.09	5.24	0.14
	DS	13	8	5.60	0.10	4.95	0.13
3	All	36	52	5.45x	0.06	5.25x	0.05
	HE	7	7	5.64	0.13	5.44	0.07
	SY	15	30	5.63	0.08	5.08	0.12
	DB	6	6	5.31	0.12	5.15	0.13
	DS	6	9	5.24	0.15	5.31	0.17
4	All	20	26	5.52x	0.09	5.20x	0.06
	HE	5	7	5.54	0.16	5.38	0.09
	SY	10	14	5.51	0.11	5.42	0.14
	DB	2	3	5.61	0.24	5.07	0.12
	DS	3	2	5.43	0.20	4.94	0.20
Mature	All	75	82	5.47x	0.10	5.24x	0.05
	HE	22	25	5.54	0.07	5.53	0.12
	SY	41	44	5.52	0.05	5.35	0.15
	DB	1	4	5.41	0.35	5.14	0.13
	DS	11	9	5.42	0.11	4.95	0.11

a,b,c = Least squares means of overall average LACT % by breed of dam within each year with different alphabetic letters are significantly different ($P<0.05$)
l,m = Least squares means of overall average LACT % for all cows with different alphabetic letters are significantly different ($P<0.01$)
x = Least squares means of overall average LACT % by age of dam within each year with different alphabetic letters are significantly different ($P<0.05$)

Protein

PROT% ranged from an average of 3.26% for DB and DS 4-year olds in both years to 3.90% for the single DB cow in 1976.

Lactose

LACT% ranged from 4.94% for the 3-year old DS in 1977 to an average of 5.67% for the HE and SY 2-year olds in 1976.

Effect of Breed of Dam on Constituent Percentages

Analyses of covariance of average constituent percentages (Table I.11) show that the effect of breed accounted for a highly significant source of variation ($P<0.001$) only for the 1977 LACT%. Differences between all breeds for BF% and PROT% were not significant ($P>0.05$) as indicated in Tables I.8-10, although generally the HE tended to produce the highest BF% each year.

Breed differences for PROT% were negligible. For LACT% however, HE and SY produced significantly ($P<0.05$) more than DB and DS groups.

As noted, BF% values for the dairy crossbreds in this study were higher than those reported in the literature. Because dairy selection programs have usually emphasized milk volume rather than constituent content (Cerbulis and Farrell, 1975) BF% may either be a reflection of breed effect or an effect of the suckling or milking regime. Christensen *et al.*, (1973) found that BF content was less affected by environmental factors like calving interval and

Table I.11. Analyses of covariance of average constituent percentages, Kinsella 1976-1977.[a]

Source	d.f.		F TESTS					
			BF %		PROT %		LACT %	
	1976	1977	1976	1977	1976	1977	1976	1977
Age of dam	3	3	4.61**	2.41	1.92	1.91	0.18	0.31
Breed of dam	3	3	1.00	1.00	0.66	0.58	2.46	9.14***
Age x Breed of dam	9	9	0.48	1.41	0.76	1.83	1.38	1.48
Sex of calf	1	1	0.27	0.88	0.36	0.63	0.01	1.36
Sex x Breed	3	3	0.89	1.27	0.95	3.67*	0.24	4.09**
Age of calf	1	1	0.40	3.95*	0.12	0.01	1.38	2.38
Error	185	221						
Total	205	241						

* $P<0.05$; ** $P<0.01$; *** $P<0.005$

herd average than either milk or BF yields. As these dairy types in the present study were all crossbreds, the BF content may also be affected by crossbreeding or may be a factor confounded with the method of milk removal.

Most published reports (Schmidt, 1971; Gaunt, 1973 and Preston and Willis, 1974) concluded that milk and BF yields are traits with low heritabilities of between 0.2 and 0.3, although Tong *et al.*, (1977) calculated heritabilities for milk and BF yields of up to 0.5. While crossing results in heterosis for traits of low heritability like milk production, the heritability of constituent percentages is generally higher (Preston and Willis, 1974). There is probably a combination of factors involved that influence the BF content of milk and further investigation is required.

Effect of Age of Dam

The effect of age of dam accounted for a significant (P<0.01) source of variation only for 1976 BF% (Table I.11). As shown in Tables I.8-10, mature dams yielded significantly (P<0.01) more BF% than other age groups. Generally, there were no marked age trends for the other constituent percentages of PROT and LACT.

Whereas Christensen *et al.*, (1973) found that BF% was not considerably influenced by either age of dam or calving interval, Schmidt (1971) noted 0.2 and 0.4 unit decreases in butterfat% from the first to fifth lactation, but a negligible change in protein with increasing age.

June and September Constituent Percentages and Seasonal Variation

As illustrated in Figure I.5, for dairy cows the negative relationship between milk yield and component percentages results in curves for component percentages that are inversely proportional to those of milk (Schmidt, 1971; Christensen *et al*., 1973; Preston and Willis, 1974, and Cerbulis and Farrell, 1975). According to Schmidt (1971) this may be due to the fact that butterfat, protein and solids-not-fat percentages are high in colostrum in the first part of the lactation. He suggested that the protein and solids-not-fat percentages rise around the sixth month of lactation due to the possible hormonal effects of pregnancy because if the cow is pregnant, these levels tend to remain constant.

Lactose percent, according to Schmidt (1971) is low in colostrum, but usually increases to a high level at the start of lactation and exhibits a small decline near the end.

Trends for seasonal variation of constituents are shown for Herefords, Angus, Galloway and crossbreds of the same breed composition (Figure I.5) (Gleddie and Berg, 1968; Hall, 1971). Gleddie and Berg reported an increase in BF% from the beginning of lactation, first measured at 35 days, followed by a sharp increase at the end of 155 days. Seasonal fluctuations were small for protein. The total solids and SNF% decreased to the second month and then

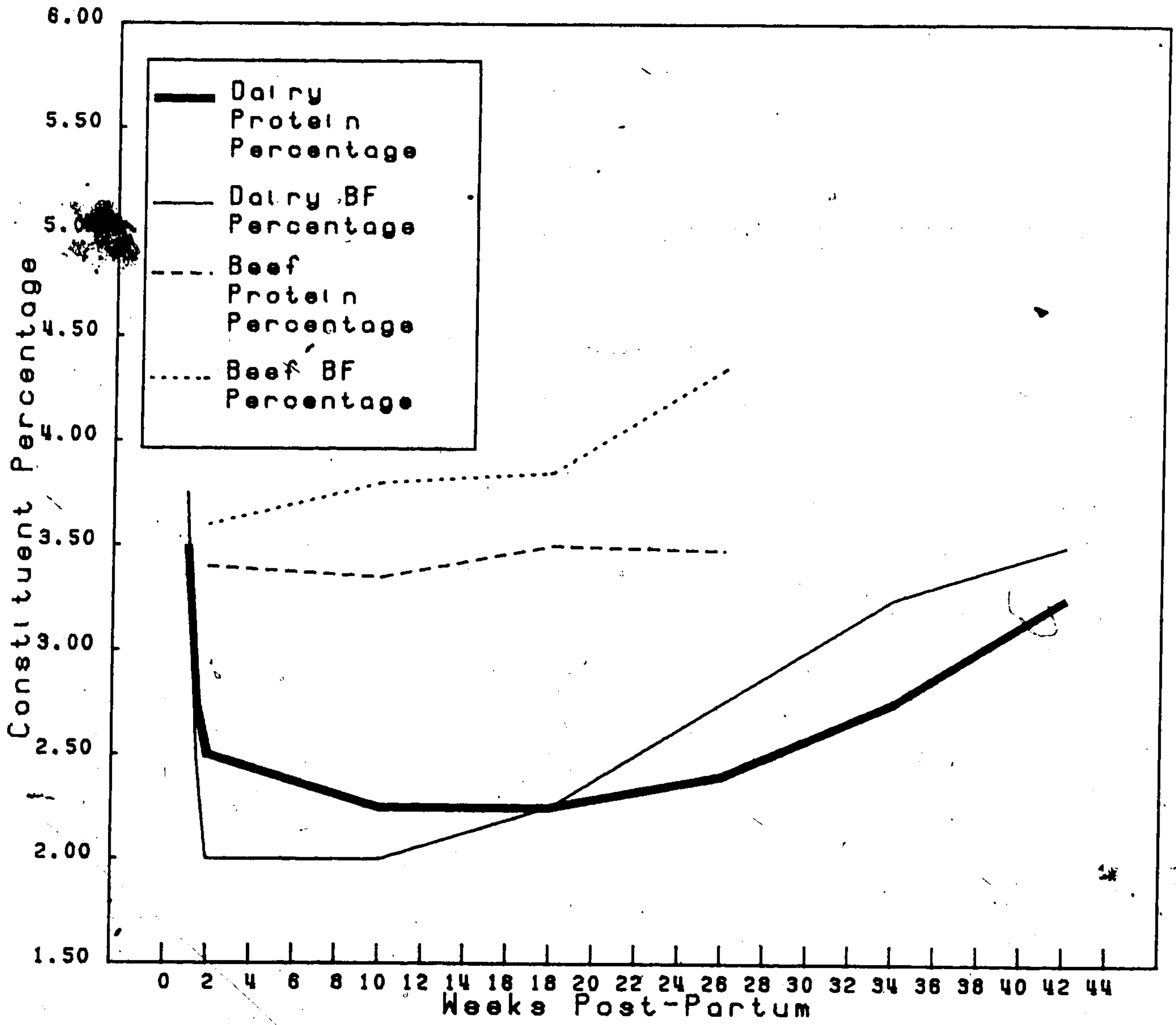

Figure I.5 Milk constituent trends for dairy and beef cows increased gradually, more nearly similar to the dairy breeds.

It may be possible that differences noted in seasonal fluctuations for constituents may be attributed to the variation in times of measurement during the lactation. For example, the beef cows in Gleddie's experiment may have been first measured after the initial peak in milk yield. On the other hand, Gleddie (1968) reported a small but positive correlation coefficient between milk yield and BF%, contrary to results noted in most published reports, which might account for the differences in patterns. In another study conducted in Rhodesia, Richardson *et al.*, (1977) found that BF% increased signficantly at 5 weeks post-partum during the peak yields. These workers suggested that the BF% increase was related to a corresponding increase in cow weight.

Based on the foregoing, there seem to be no consistent trends for seasonal variation in constituent percentages for beef cattle.

Results taken from the present study are illustrated in Figure I.6 averaged across breeds.

Least squares means and standard errors of June and September constituent percentages are presented in Tables I.12 through I.17. Differences between the two periods for all constituents were significantly ($P<0.01$) higher for September when averaged across all breeds. As illustrated in Figure I.6 BF% consistently had the highest increases, averaging 0.41 between periods over both years. Protein %

Table I.12. Least squares means and standard errors of average daily June and September butterfat percentages, Kinsella 1976.

	Breed	No. of cows 1976	Average Daily BF %				
			June		September		
			Mean	S.E.	Mean	S.E.	Change
Grand Total	All	206	4.44	0.09	4.80	0.07	0.36**
	HE	45	4.71a	0.14	4.78a	0.12	0.07
	SY	102	4.32b	0.09	4.75a	0.08	0.43**
	DB	26	4.47b	0.26	4.81a	0.22	0.34
	DS	33	4.26b	0.16	4.81a	0.14	0.55**
Age in years							
2	All	75	4.22x	0.10	4.71x	0.09	0.49**
	HE	11	4.61	0.24	4.81	0.20	0.20
	SY	36	4.23	0.13	4.65	0.11	0.42
	DB	15	4.31	0.20	4.52	0.17	0.21
	DS	13	3.74	0.23	4.87	0.19	0.13
3	All	36	4.50x	0.14	4.83xy	0.12	0.33
	HE	7	4.54	0.30	4.70	0.25	0.16
	SY	15	4.2[illegible]	0.21	5.05	0.18	0.76
	DB	8	4.79	0.28	4.70	0.24	-0.07
	DS	6	4.37	0.34	4.89	0.29	0.52
4	All	20	4.19x	0.21	4.49x	0.18	0.36
	HE	5	4.48	0.36	4.59	0.31	0.11
	SY	10	4.14	0.25	4.41	0.21	0.27
	DB	2	3.62	0.56	4.47	0.47	0.85
	DS	3	4.30	0.46	4.50	0.39	0.20
Mature	All	75	4.90y	0.22	5.18y	0.18	0.28
	HE	22	5.22	0.17	5.03	0.14	-0.19
	SY	41	4.62	0.13	4.88	0.11	0.26
	DB	1	5.14	0.81	5.56	0.69	0.42
	DS	11	4.61	0.25	5.27	0.21	0.66

a,b = Least squares means of constituent percentages by breed of dam within months with different letters are significantly different ($P<0.05$)

x,y = Least squares means of constituent percentages by age of dam within months with different letters are significantly different ($P<0.05$)

* significant at $P<0.05$; ** significant at $P<0.01$

Table I. 13. Least squares means and standard errors of average daily June and September protein percentages, Kinsella 1976.

	Breed	No. of cows 1976	Average Daily Protein %				
			June		September		
			Mean	S.E.	Mean	S.E.	Change
Grand Total	All	206	3.47	0.05	3.64	0.03	0.17**
	HE	45	3.40a	0.07	3.71a	0.06	0.31**
	SY	102	3.38a	0.05	3.62a	0.04	0.24**
	DB	26	3.60a	0.14	3.69a	0.10	0.09
	DS	33	3.50a	0.09	3.54a	0.06	0.04
Age in years							
2	All	75	3.62x	0.06	3.65x	0.04	0.03
	HE	11	3.50	0.13	3.76	0.10	0.26
	SY	36	3.43	0.07	3.59	0.05	0.16
	DB	15	3.95	0.11	3.75	0.09	-0.20
	DS	13	3.59	0.12	3.51	0.09	-0.08
3	All	36	3.49x	0.06	3.58xy	0.06	0.09
	HE	7	3.42	0.16	3.62	0.12	0.20
	SY	15	3.33	0.11	3.67	0.08	0.34
	DB	8	3.59	0.15	3.56	0.11	-0.03
	DS	6	3.62	0.18	3.46	0.14	-0.16
4	All	20	3.31x	0.11	3.54x	0.09	0.23
	HE	5	3.28	0.19	3.75	0.14	0.47
	SY	10	3.28	0.13	3.60	0.10	0.32
	DB	2	3.25	0.30	3.26	0.22	0.01
	DS	3	3.41	0.24	3.55	0.18	0.14
Mature	All	75	3.46x	0.12	3.79y	0.09	0.33**
	HE	22	3.38	0.09	3.70	0.07	0.32
	SY	41	3.49	0.07	3.62	0.05	0.13
	DB	1	4.60	0.43	4.21	0.32	-0.39
	DS	11	3.38	0.13	3.62	0.10	0.24

a = Least squares means of constituent percentages by breed of dam within months with different letters are significantly different ($P<0.05$)

x,y = Least squares means of constituent percentages by age of dam within months with different letters are significantly different ($P<0.05$)

* significant at $P<0.05$; ** significant at $P<0.01$

Table I. 14. Least squares means and standard errors of average daily June and September lactose percentages, Kinsella 1976.

	Breed	No. of cows 1976	Average Daily Lactose % June Mean	June S.E.	September Mean	September S.E.	Change
Grand Total	All	206	5.11	0.04	5.86	0.05	0.75**
	HE	45	5.28a	0.07	5.91a	0.06	0.63**
	SY	102	5.26a	0.04	5.90a	0.05	0.64**
	DB	26	4.90b	0.12	5.79a	0.15	0.89**
	DS	33	4.94b	0.08	5.85a	0.09	0.86**
Age in years							
2	All	75	5.12x	0.05	5.88x	0.06	0.76**
	HE	11	5.36	0.11	5.97	0.14	0.61
	SY	36	5.34	0.06	5.99	0.08	0.65
	DB	15	4.63	0.10	5.50	0.12	0.87
	DS	13	5.13	0.11	6.07	0.13	0.94
3	All	36	5.04x	0.07	5.86x	0.08	0.82**
	HE	7	5.29	0.14	5.98	0.17	0.69
	SY	15	5.29	0.10	5.97	0.12	0.68
	DB	8	4.93	0.13	5.69	0.16	0.76
	DS	6	4.67	0.16	5.80	0.19	1.13
4	All	20	5.16x	0.10	5.89x	0.12	0.73**
	HE	5	5.20	0.17	5.88	0.21	0.68
	SY	10	5.28	0.12	5.74	0.14	0.46
	DB	2	5.08	0.27	6.15	0.32	1.07
	DS	3	5.09	0.22	5.78	0.26	0.69
Mature	All	75	5.12x	0.10	5.82x	0.12	0.70**
	HE	22	5.27	0.08	5.81	0.10	0.54
	SY	41	5.14	0.06	5.89	0.07	0.75
	DB	1	4.98	0.39	5.84	0.46	0.86
	DS	11	5.09	0.12	5.75	0.14	0.66

a,b = Least squares means of constituent percentages by breed of dam within months with different letters are significantly different ($P<0.05$)

x = Least squares means of constituent percentages by age of dam within months with different letters are significantly different ($P<0.05$)

* significant at $P<0.05$; ** significant at $P<0.01$

Table I.15. Least squares means and standard errors of average daily June and September butterfat percentages, Kinsella 1977.

	Breed	No. of Cows 1977	Average Daily BF %				
			June		September		
			Mean	SE	Mean	SE	Change
Grand Total	All	242	4.74	0.08	5.20	0.08	0.46**
	HE	58	5.04a	0.12	5.11a	0.13	0.07
	SY	123	4.57b	0.08	5.19a	0.08	0.62**
	DB	33	4.67b	0.24	5.12a	0.24	0.45
	DS	28	4.68b	0.19	5.38a	0.19	0.70**
Age in years							
2	All	82	4.50x	0.14	5.00x	0.14	0.50**
	HE	19	4.[illegible]	0.19	4.87	0.19	0.01
	SY	35	4.58	0.14	4.99	0.14	0.41
	DB	20	4.61	0.36	5.29	0.36	0.68
	DS	8	3.93	0.34	4.84	0.34	0.91
3	All	52	4.80xy	0.14	5.22x	0.14	0.42*
	HE	7	4.85	0.18	5.10	0.18	0.25
	SY	30	4.84	0.33	5.15	0.32	0.31
	DB	6	4.08	0.35	4.69	0.34	0.61
	DS	9	5.44	0.45	5.93	0.44	0.49
4	All	26	5.10y	0.22	5.42x	0.22	0.32
	HE	7	5.24	0.22	5.30	0.22	0.06
	SY	14	5.16	0.38	5.50	0.38	0.34
	DB	3	5.07	0.32	5.42	0.32	0.35
	DS	2	4.92	0.53	5.47	0.55	
Mature	All	82	4.57x	0.14	5.16x	0.14	0.59**
	HE	25	5.22	0.30	5.16	0.34	-0.06
	SY	44	3.70	0.39	5.10	0.39	1.40
	DB	4	4.94	0.34	5.07	0.33	0.13
	DS	9	4.43	0.28	5.29	0.28	0.86

a,b = Least squares means of consitutent percentages by breed of dam within months with letters are significantly different (P<0.05).

x,y = Least squares means of constituent precentages by age of dam within months with letters are significantly different (P<0.05).

* Significant at P<0.05; ** Significant at P<0.01.

Table I.16. Least squares means and standard errors of average daily June and September protein percentages, Kinsella 1977.

			Average Daily Protein %				
			June		September		
	Breed	No. of cows 1977	Mean	S.E.	Mean	S.E.	Change
Grand Total	All	242	3.31	0.03	3.57	0.03	0.26**
	HE	58	3.31a	0.04	3.65a	0.05	0.34**
	SY	123	3.29a	0.02	3.56a		
	DB	33	3.34a	0.07	3.50a	0.10	0.16
	DS	28	3.30a	0.06	3.59a	0.07	0.29**
Age in years							
2	All	82	3.39xy	0.04	3.61x	0.06	0.22**
	HE	19	3.48	0.06	3.73	0.07	0.25
	SY	35	3.27	0.04	3.47	0.06	0.20
	DB	20	3.31	0.11	3.71	0.14	0.40
	DS	8	3.50	0.10	3.53	0.14	0.03
3	All	52	3.31x	0.04	3.66xy	0.06	0.35**
	HE	7	3.32	0.08	3.70	0.07	0.38
	SY	30	3.43	0.10	3.68	0.13	0.25
	DB	6	3.37	0.11	3.33	0.14	-0.04
	DS	9	3.13	0.14	3.93	0.18	0.80
4	All	26	3.24xz	0.07	3.54x	0.09	0.30**
	HE	7	3.32	0.07	3.73	0.09	0.41
	SY	14	3.16	0.12	3.63	0.15	0.47
	DB	3	3.28	0.10	3.50	0.43	0.22
	DS	2	3.22	0.16	3.31	0.21	0.09
Mature	All	82	3.29xy	0.04	3.49xz	0.05	0.20**
	HE	25	3.12	0.09	3.44	0.12	0.32
	SY	44	3.30	0.12	3.45	0.16	0.15
	DB	4	3.39	0.10	3.47	0.13	0.08
	DS	9	3.36	0.09	3.59	0.11	0.23

a = Least squares means of consituent percentages by breed of dam within months with different letters are significantly different (P<0.05).

x,y,z= Least squares means of constituent percentages by age of dam within months with different letters are significantly different (P<0.05).

* Significant at P<0.05; ** Significant at P<0.01.

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Table I.17. Least squares means and standard errors of average daily June and September lactose percentages, Kinsella 1977.

	Breed	No. of Cows	Average Daily Lactose %				
			June		September		
		1977	Mean	S.E.	Mean	S.E.	Change
Grand Total	All	242	5.16	0.04	5.33	0.04	0.17**
	HE	[illegible]	5.45a	0.07	5.48a	0.06	0.03
	SY	123	5.27a	0.04	5.39a	0.04	0.12
	DB	33	4.93b	0.13	5.37a	0.11	0.44**
	DS	28	5.01b	0.10	5.07b	0.09	0.06
Age in years							
2	All	82	5.26x	0.07	5.32x	0.07	0.06
	HE	19	5.52	0.10	5.49	0.09	-0.03
	SY	35	5.50	0.07	5.41	0.07	-0.09
	DB	20	5.15	0.19	5.33	0.17	0.18
	DS	8	4.86	0.18	5.05	0.16	0.19
3	All	52	5.18x	0.07	5.31x	0.07	0.13
	HE	7	5.45	0.10	5.42	0.09	-0.03
	SY	30	4.87	0.18	5.30	0.15	0.43
	DB	6	4.90	0.19	5.40	0.16	0.50
	DS	9	5.48	0.24	5.13	0.21	-0.35
4	All	26	5.09x	0.12	5.32x	0.10	0.23
	HE	7	5.32	0.12	5.44	0.10	0.12
	SY	14	5.47	0.20	5.38	0.18	-0.09
	DB	3	4.82	0.17	5.33	0.15	0.51
	DS	2	4.75	0.29	5.12	0.25	0.37
Mature	All	82	5.13x	0.07	5.35x	0.06	0.22**
	HE	25	5.50	0.16	5.56	0.14	0.06
	SY	44	5.26	0.21	5.45	0.18	0.19
	DB	4	4.84	0.18	5.43	0.16	0.59
	DS	9	4.93	0.15	4.97	0.13	0.04

a,b = Least squares means of constituent percentages by breed of dam within months with different letters are significantly different ($P<0.05$).

x = Least squares means of constituent percentages by age of dam within months with different letters are significantly different ($P<0.05$).

* Significant at $P<0.05$; ** Significant at $P<0.01$.

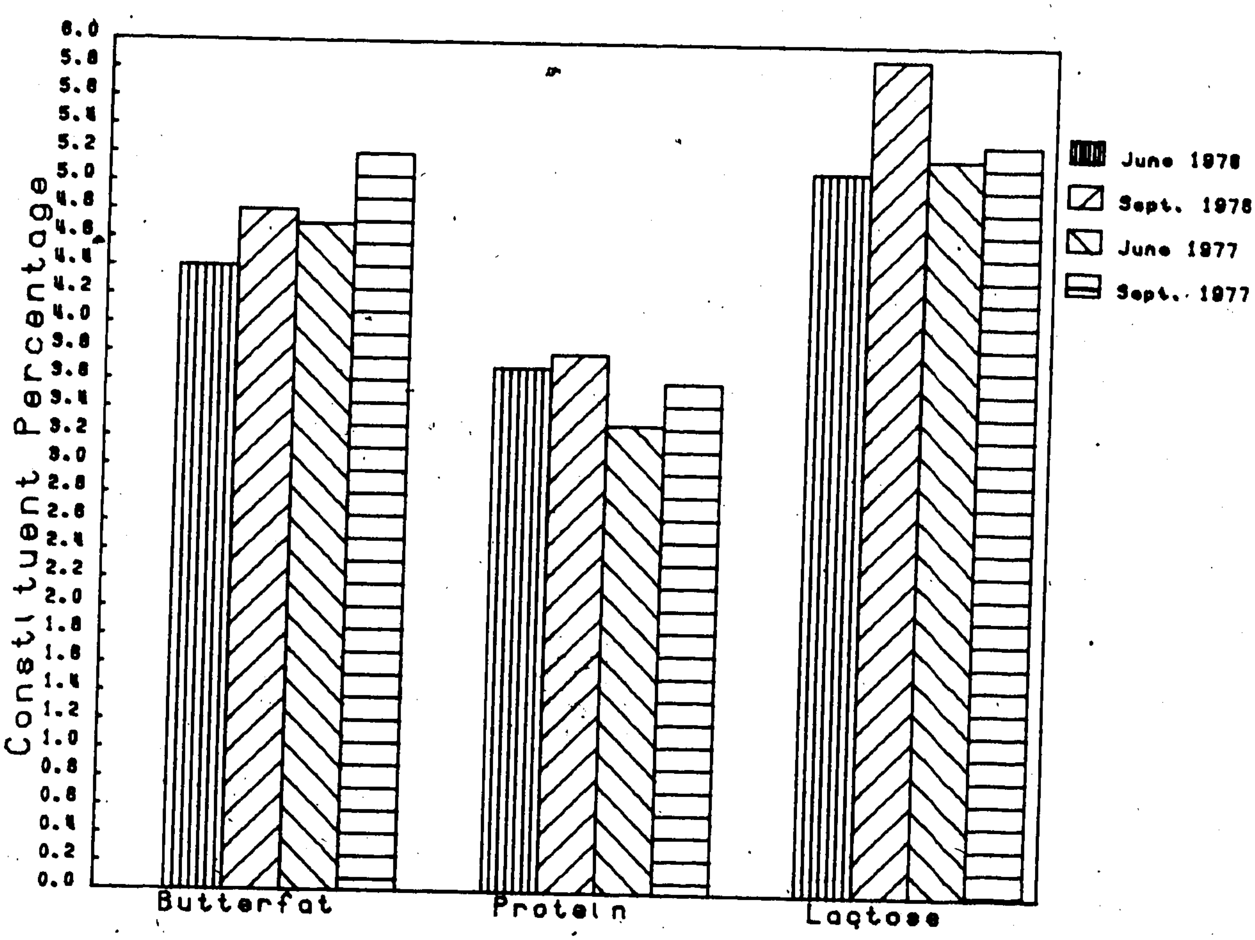

Figure I.6 June and September averages for butterfat, protein and lactose percent, Kinsella 1976–1977 changed less noticeably, increasing by 0.22 units. Lactose % increased by 0.75 in 1976 but by only 0.17 in 1977. The 1977 results are comparable to trends reported by Schmidt (1971).

For breed-age categories (Tables I.12-17), there was no consistent trend for variation in components. Protein and lactose % increases were significant for most breeds. Although some age differences for PROT% were also demonstrated, no specific trends for seasonal variation could be determined [illegible] dam.

Table I.18 shows [illegible] of covariance of June and September constitu[illegible]tages. The effects of breed of dam accounted for signi[illegible]nt variation in June BF% (P<0.05) in 1977, in June LACT% (P<0.01) for both years, and for September LACT% in 1977 (P<0.01). The HE breed produced significantly (P<0.01) higher BF% than all other breeds in June each year. The DB and DS groups produced significantly less LACT% (P<0.05) than HE and SY in June. However, no other significant differences were observed for seasonal variation between breeds.

Table I.18 shows that the age of dam accounted for a significant (P<0.05) source of variance for June and September constituents in 1976. Results in Tables I.12 through I.17 indicate that only mature dams produced more BF% than other age groups. Although some age differences for PROT% are also demonstrated, no specific trends for seasonal variation could be determined by age of dam.

Table I.18. Analyses of covariance of June and September butterfat, Kinsella 1976-1977

Source	D.F.		F TEST											
			June BF		Sept. BF		June PROT		Sept. PROT		June LACT		Sept. LACT	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Age of dam	3	3	3.37*	2.19	2.75*	1.06	2.03	1.71	1.82	1.77	0.38	0.79	0.07	0.07
Breed of dam	3	3	2.18	3.23*	0.25	0.51	1.10	0.17	1.53	1.03	5.39**	6.88**	0.23	4.89**
Age x Breed	9	9	0.69	1.72	0.51	0.64	0.83	1.56	1.12	2.04*	1.60	1.78	1.00	0.44
Sex of calf	1	1	0.14	0.26	0.22	0.98	0.02	0.08	1.04	0.92	0.27	0.79	0.32	0.78
Age of calf	1	1	1.48	0.02	6.46*	9.21**	3.15	0.74	9.54**	0.30	5.92*	1.69	0.06	1.05
Error	188	224												
Total	205	241												

* Significant at P<0.05; ** Significant at P<0.01.

Relationships between June, September and Average Milk Yields and Constituent Percentages

Table I.19 presents the phenotypic correlations of all milk yields and constituent percentages for 1976 and 1977.

Table I.20 presents correlations examined in this study.

a) Correlations of June with September Milk Measurements:

June and September milk yields were moderately correlated (Table I.20 a); r = 0.55 and 0.58 for 1976 and 1977 indicating that other factors during the lactation would influence the daily yields. Each of June and September constituents had low to moderate values ranging from 0.22 for June with September LACT% in 1977 to 0.47 for June with September PROT% in 1976.

b) Correlations of Milk Yields with Constituent Percentages:

Generally, all measurements of milk yield were negatively correlated (P<0.05) with all constituent percentages (Table I.20 b) showing little variation in trends for overall, June and September measurements. Average milk yield with average BF, PROT and LACT% had r values of -0.13, -0.29 and -0.01 respectively for 1976 and similar correlations for 1977. These values correspond to those in the literature reviewed for dairy (Schmidt, 1971; Preston and Willis, 1974, and Cerbulis and Farrell, 1975) but differ with some of the

Table I.19. Phenotypic correlations of milk yields and milk constituent percentages: 1976 data below diagonal (N=210); 1977 data below diagonal (N=242), Kinsella.

	AM	JM	SM	AB	JB	SB	AP	JP	SP	AL	JL	SL
AM		.89	.87	-.13	-.10	-.10	-.29	-.20	-.32	-.01ns	-.08ns	-.04
JM	.92	--	.55	-.09ns	-.11	-.02ns	-.28	-.27	-.21	.06ns	.08	.03
SM	.85	.58	--	-.14	-.07ns	-.16	-.24	-.08ns	-.36	-.08ns	-.14	.03
AB	-.13	-.14	-.09	--	.85	.75	.24	.14	.29	-.08ns	-.14	0
JB	-.24	-.29	-.12	.79	--	.29	.16	.14	.13	-.14	-.22	-.02ns
SB	.03ns	.07ns	-.02ns	.77	.24	--	.23	.08	.36	.03	.03	.02ns
AP	-.28	[illegible]	-.30	.26	.16	.25	--	.90	.81	-.60	-.56	0
JP	-.20	-.19	-.17	.09	.11	.03	.78	--	.47	0.59	-.66	-.35
SP	-.26	-.16	-.32	.31	.15	.34	.89	.40	--	-.42	-.25	-.49
AL	-.13	-.12	-.10	.02ns	.07ns	-04ns	-.44	-.41	-.34	--	.83	.86
JL	-.13	-.10	-.19	.03ns	.05ns	-.01ns	-.34	-.47	-.15	.83	--	.44
SL	-.06ns	-.09ns	-.01ns	.01ns	.06ns	-.05ns	-.34	-.13	-.41	.73	.22	--

ns = not significant at P>0.05

Table I.20. Phenotypic correlations of milk yields and milk constituent percentages, Kinsella 1976-1977.

a) Variables	1976	1977
JM SM	.55	.58
JB SB	.29	.24
JP SP	.47	.40
JL SL	.44	.22
b) Variables	**1976**	**1977**
AM AB	-.13	-.13
AM AP	-.29	-.28
AM AL	-.01	-.73
JM JB	-.11	-.29
JM JP	-.27	-.19
JM JL	.08	-.10
SM SB	-.16	.02
c) Variables	**1976**	**1977**
SM JP	-.36	-.32
SM SL	.03	-.01
AB AP	.24	.26
AB AL	-.08	.02
AB AL	-.60	-.44
JB JP	.14	.11
JB UL	-.22	.05
JP JL	-.66	-.47
SB SP	.36	.34
SB SL	.02	-.05
SP SL	-.49	-.41

A = Average, J = June, S = September, M = Milk yield,
B = Butterfat %, P = Protein %, L = Lactose %.

coefficient values for beef breeds reported by Gleddie and Berg (1968). These authors found that BF% was positively correlated with milk yield and negatively correlated with PROT and solids-not-fat%. Jeffery (1971) cited literature with similar values between BF% and milk yield. In the present study, there was a tendency for negative correlations between the overall averages of milk yield and protein percentages with r values of -0.29 and -0.28 for 1976 and 1977 respectively (P<0.01).

c) Intercorrelations of Constituent Percentages:

The intercorrelations between constituent percentages were variable, ranging from -0.66 between June PROT% and LACT% in 1976 to a low and not significant correlation between average BF% and LACT% (Table 1.20 c). Generally, BF% and PROT% had moderate to low positive r values. The correlations between BF% and LACT% were low and not significant, and PROT% and LACT% were moderately and negatively correlated. These trends were similar for both months.

Jeffery (1971) reports all r values as positive among % milk components, similar to Gleddie and Berg (1968) and other workers cited in his study.

D. CONCLUSIONS

A milking experiment was conducted to examine differences in milk yields and constituent percentages between Hereford, Beef-Synthetic, Dairy-Beef and

Dairy-Synthetic breed groups of range cows. There were significant breed differences between Hereford and Beef-Synthetics, the latter yielding more milk than Herefords. However, the Dairy-Beef and Dairy-Synthetic cows yielded significantly more milk than the beef breeds and exhibited greater persistency each year, suggesting that there are differences in both average daily milk yields and seasonal variation between dairy crosses and beef cows on range.

Age trends for milk production were less noticeable but generally, 4-year old and mature cows yielded more milk.

Constituent percentages for butterfat, protein and lactose are within the range reported in the literature for range beef cattle although the 4.8% average for butterfat averaged across all breeds for both years was slightly higher than values reported in other published material. Differences between breeds for butterfat% and protein% were not significant although Hereford dams tended to produce the highest butterfat content each year. Breed differences for protein% were negligible. The Hereford and Beef-Synthetic cows produced a significantly higher lactose% content than the dairy crosses. All constituent percentages were significantly higher in September than in June. No consistent trend for variation in composition was noted between breeds.

It is not clear whether differences in milk yield are the result of breed differences and heterosis resulting from crossbreeding, or are more a reflection of the milking regime. Results indicate however that the introduction of a dairy breed into a beef line will result in higher milk production under range suckling conditions compared to beef breeds and crosses.

The results indicate a high butterfat content for the dairy crosses in this study which raises some interesting points for further examination. Is butterfat% a reflection of breed effects *per se* or rather, more influenced by the suckling or milking regime? Or, as dairy cows in this experiment were all crossbred, is the butterfat% also affected by crossbreeding? It is commonly held that crossbreeding results in heterosis for traits of low heritability like milk production; however, according to the literature reviewed, the heritability for all constituent percentages is much higher at approximately 0.5. More investigations are required.

Based on the high butterfat% and average daily milk yield of dairy crosses used in this study, it seems likely that calves of DS and DB dams ingested more total energy than HE and SY calves, thereby affecting preweaning growth response. For butterfat% alone, HE and SY calves ingested approximately 325 grams per day compared to 395 grams per day ingested by calves of dairy cross dams. This in turn may influence growth response over and above the inherent growth potential of the crossbreds, and consequently result in higher weaning weights.

II. FACTORS INFLUENCING LACTATION PERFORMANCE OF RANGE BEEF AND DAIRY-BEEF COWS

A. INTRODUCTION

Many studies have indicated that increasing milk production in a cow-calf operation can be effected by crossing dairy with beef breeds (Long, 1980).

In the preceding chapter significant differences were found in milk yield among breed and within age of dam categories. Whether the effects of breed and age of dam are confounded to a great degree by other factors such as the nature of the suckling regime is not clear. However, the results suggested that breed and age of dam effects exert some influence on the level of milk production and associated constituent yields. The nature of the effects of breed and age of dam on milk yield has not been reported extensively. For example, it is not known if breed of dam effects on milk yield are more pronounced at the beginning or end of lactation. This may have practical implications for operations that consider early weaning as part of the program.

In addition, of interest to the producer are factors other than the breed and age of dam such as calf age, sex and birthweight, and cow weight changes before and after calving which may influence milk yields and constituent percentage yields.

The purpose of this part of the study was to determine the influence of the above cow and calf factors on June, September and average milk yields using multiple regression analyses. A limited analysis of the effect of these factors on constituent yields was also conducted.

B. MATERIALS AND METHODS

Data were collected in 1976 and 1977 from a milking experiment involving June and September measurements of lactation. The 206 (1976) and 242 (1977) cows ranging from 2 to 10 years of age represented four beef and dairy-beef groups: Hereford (HE), Beef-Synthetic (SY), Dairy-Beef (DB) and Dairy-Synthetic (DS). The general management and breeding program of the experimental herd were described in Chapter I. A detailed account of the milking experiment was also provided earlier.

Statistical Analyses

Dependent variables recorded for the purpose of this study were June and September milk yields and their overall averages and constituent yields of butterfat (BF), protein (PROT) and lactose (LACT) for each year.

Independent variables analyzed as categories were breed of dam (B), age of dam (A)and sex of calf (S). Quantitative independent variables, ie: covariates, that were included either alone or together were age of calf (CA), calf birthweight (BW), cow winter weight loss from October of the preceding year to calving (WWLS) and cow post-calving average daily gain from calving to September (cow ADGCS). Calf average daily gain from birth to September (calf ADGBS) was also included as an independent variable.

The analyses of covariance for unequal subclass numbers (Mehlenbacher, 1978) and levels for the main effects of B, A, S and CA are as described in Chapter I.

To determine the influence of cow and calf variables with milk variables, multiple stepwise regression analyses were used.

As trends were similar for each year, regressions for 1976 were not computed.

Stepwise Multiple Regressions

Stepwise multiple regressions of milk and constituent variables on combined cow and calf variables were computed using the SPSS REGRESSION as outlined by Nie *et al.*, (1975). Some of the stepwise regression models involved the sequential regression of variables which entered the equations in a hierarchical order based on partial correlations. Some of the variables which entered were quantitative or continuous; others such as A, B, A x B and S were discreet or non-continuous. In the other stepwise regressions, some of the variables were forced to enter the equations.

Preliminary analyses of the data examined the combined effects of cow and calf variables on average milk and constituent yields for both years using three models of regression. In the first model, the effects of calf age and sex were not included (Table II.1,Equations 1a and 1b). This stepwise multiple regression analysis provided some indication of the variance of overall average milk yield explained primarily by genetic effects of the breed and age of dam. The association of the effects of management factors of cow winter weight loss during gestation and post-calving weight gain on lactation performance were also examined.

In the second stepwise regression model, age and breed of dam and age and sex of calf were ignored (Table II.1, Equations 2a and 2b). This method permitted the introduction of only calf birthweight and cow weight changes, factors that may be affected by management.

All variables in the last two models were introduced on the basis of the highest partial correlations with the dependent milk variable. No variables were forced to enter the equation. If two independent variables were correlated, some of the effect of the first is removed by the subsequent variable. Consequently, the additional variance explained by a variable over and above the preceding variables is conditional to the preceding variables entered into the regression equation.

A third model of stepwise regression analysis involved the sequential regression of average milk, BF, PROT and LACT yields on all cow and calf factors in 1977 (Tables II.2 and II.3). However, independent variables of interest were forced to enter the equation based on *a priori* reasoning. This model allowed examination of the relative weight of association of one variable over another with the dependent milk variable. It also provided information as to the feasibility of using various milk component traits as indicators of milk performance.

Other regression models were computed as outlined by Overall and Klett (1972). These regressions permitted the examination of the influence of each of the cow and calf factors on the dependent milk variables of average milk, June and September yields. All other variables were ignored (Tables II.5 through II.10).

These regressions were computed by: a) ignoring the effects of A, B, A x B, S and CA and then forcing in the variables of interest; b) forcing the effects of A, B, and A x B to enter the equation before forcing in the variable of interest, and c) forcing all the effects of A, B, A x B, S and CA to enter the equations before the variable of interest. Methods b) and c) allowed examination of the effects of individual variables over and above main effects.

C. RESULTS AND DISCUSSION

Factors Influencing Average Daily Milk and Constituent Yields

Stepwise Multiple Regression Analyses

Analyses of the data are presented in Table II.1 for regressions using methods 1 and 2 for comparison of the 1976 and 1977 results.

Results indicated the age of dam x breed of dam interaction (AxB) alone accounted for an average of 34.0% of the variance (P<0.01) in average milk yields each year (Table II.1, Equations 1a and 1b). All other cow and calf variables including birthweight and cow weight changes during gestation and lactation accounted for a small and not significant proportion of the variance.

As the first three independent variables explained most of the variance in milk yield, the equations were limited to the third step of the regression analysis.

In Equations 2a and 2b (Table II.1) calf birthweight, cow winter weight loss and ADG from calving to September explained little of the variance. When compared with the high association with milk yield shown by B and A effects, results would suggest that more effects of BW, WWLS and cow ADGCS were largely accounted for by the age and breed of dam variables.

Equations 1a,b, c and d (Table II.2) present stepwise regressions of 1977 average daily milk, butterfat, protein and lactose yields on cow and calf variables forced to enter the equations.

Table II.1. Stepwise regressions of average daily milk yield (Kg/day) on cow and calf variables, Kinsella 1976-1977.

Equation	Independent variables entered sequentially into forward regression	% Total variance explained (R^2 x 100)	% Additional variance explained	Partial b	SEb[4]
1. a) 1976	B x A of dam	34.1	-	0.17	0.03
	Calf Birthweight[1]	35.9	1.80	0.04*	0.02
	Age of dam[2]	36.3	0.60	0.10	0.09
1. b) 1977	B x A of dam	33.8	-	0.17	0.03
	Calf Birthweight[1]	36.8	3.00	0.06*	0.02
	Age of dam[2]	37.8	1.00	1.63	0.09
2. a) 1976	Calf Birthweight[1]	1.1	-	0.41	0.02
	Cow WWLS[1]	2.6	1.55	-	-
	Cow ADG C-S[3]	3.1	0.55	-0.25	0.25
2. b) 1977	Calf Birthweight[1]	1.2	-	0.04	0.20
	Cow ADG C-S[3]	3.0	2.80	-	-
	Cow WWLS[1]	3.1	0.10	- 0.30	0.30

[1] Kg
[2] Years
[3] Kg/day
[4] Standard error of b.
* $P<0.05$

Table II.2. Stepwise regressions of average daily milk, butterfat, protein and lactose yields (Kg/day) on cow and calf variables, Kinsella 1977.

Equation	Dependent variable	Order of forced independent variables	% Total variance explained (R^2 x 100)	% Additional variance explained	Partial b	SEb[4]
1. a)	Ave. milk yield[2]	Age of dam (A)[1]	24.6	-	-	-
		Breed of dam (B)	42.1	17.5	-	-
		A x B	43.0	1.0	-	
		Calf ADG B-S[2]	48.3	5.3	6.15**	0.70
		Calf Age[1]	57.9	9.6	-0.10	0.0
		Cow ADG C-S[2]	59.1	1.2	-0.95	0.50
		Calf Sex	60.1	1.0	0.17	0.08
		Calf Birthweight[3]	60.6	0.5	-0.36	0.02
		Cow WWLS[2]	60.7	0.1	-	-
1. b)	Ave. BF yield[2]	Age of dam[1]	28.7	-	-	-
		Breed of dam	41.8	13.1	-	-
		B x A	42.3	0.5	-	-
		Calf AG B-S[2]	49.3	7.0	0.31**	0.40
		Calf Age[1]	55.3	6.0	0.0	0.0
		Calf Birthweight[3]	57.0	1.7	0.0	0.0
		Calf Sex	58.1	1.1	0.0	0.0
		Cow ADG C-S[2]	58.4	0.3	-0.03	0.02
1. c)	Ave. PROT yield[2]	Age of dam[1]	24.6	24.6	-	-
		Breed of dam	41.8	17.2	-	-
		A x B	43.1	1.3	-	-
		Calf ADG B-S[2]	48.0	4.9	0.20**	0.02
		Calf Age[1]	57.4	9.4	0.0	0.0
		Cow ADG C-S[2]	58.3	1.9	-0.02	0.02
		Calf Sex	59.0	0.7	0.0	0.0
		Calf Birthweight[3]	59.4	0.4	0.0	0.0
		Cow WWLS[2]	59.5	0.1	0.0	0.0
1. d)	Ave. LACT yield[2]	Age of dam[1]	20.4	-	-	-
		Breed of dam	32.1	11.7	-	-
		A x B	33.1	1.0	-	
		Calf ADG B-S[2]	40.6	7.5	0.40**	0.04
		Calf Age[1]	51.8	11.2	-0.01	0.0
		Calf Sex	53.5	1.7	0.01	0.0
		Cow ADG C-S[2]	54.8	1.3	-0.05	0.03
		Calf Birthweight[3]	55.4	0.6	0.0	0.0
		Cow WWLS[2]	55.4	0.0	0.0	0.0

[1] years
[2] Kg/day
[3] Kg
[4] Standard error of b
** P<0.01

Age and breed of dam and the A x B of dam interaction accounted for a highly significant proportion of the variance ($P<0.01$) of milk variables. These effects together explained an average of approximately 42% of the variance for all milk variables except lactose yield, for which they explained 33.1% of the variance. In these equations, the amount of additional variance explained by the A x B of dam interaction was not significant, similar to results by Gaskins and Anderson (1980).

Calf ADG from birth to September and calf age both accounted for significant amounts of additional variance in all the milk variables. They each explained between 5 and 11% of the additional variance.

In Table II.3 equations 1a,b,c and d indicate that when calf ADGBS was forced to enter the equations first, it explained between 22.2 and 23.5% of the variance in each of the milk variable yields. Given that its correlation with milk yields and constituent yields is moderately high (Table II.4, $r = 0.6$) its resulting association is predictably significant ($P<0.01$).

The relationship between milk and weaning weight, a function of daily gain, is discussed in Chapter III. Many authors have noted the high correlation between milk and gain in several species. Rae (1977) concluded that milk production can be increased within a flock of sheep by indirect selection through lamb growth. Rae

Table II.3. Stepwise regressions of average daily milk, butterfat, protein and lactose yields (Kg/day) on cow and calf variables, Kinsella 1977.

Equation	Dependent variable	Order of forced independent variables	% Total variance explained ($R^2 \times 100$)	% Additional variance explained	Partial b	Sb
1. a)	Ave. milk yield	Calf ADG B-S	23.2**	-	7.34	0.61
		Calf Age	50.6**	27.4	-0.12	0.01
		Calf Sex	53.3**	2.7	0.27	0.09
		Calf BW	53.4	0.1	-0.23	0.02
		Cow ADG C-S	53.5	0.1	-0.63	0.47
		Cow WWLS	53.9	0.4	0.47	0.0
1. b)	Ave. BF yield	Calf ADG B-S	22.2**	-	0.36	0.03
		Calf Age	43.4**	21.2	-0.56	0.0
		Calf Sex	46.6**	3.2	0.14	0.0
		Cow WWLS	47.0	0.4	0.26	0.0
		Calf BW	47.6	0.6	-0.19	0.0
		Cow ADG C-S	47.6	-	-0.01	0.03
1. c)	Ave. PROT yield	Calf ADG B-S	22.2**	-	0.24	0.02
		Calf Age	49.6**	27.4	0.0	0.0
		Calf Sex	51.8**	2.2	0.01	0.0
		Calf BW	51.9	0.1	0.0	0.0
		Cow ADG C-S	51.9	-	-0.01	0.02
		Cow WWLS	52.0	0.1	0.0	0.0
1. d)	Ave. LACT yield	Calf ADG B-S	23.5**	-	0.39	0.03
		Calf Age	46.4**	22.9	-0.01	0.0
		Calf Sex	49.3**	2.9	0.01	0.0
		Calf ADG B-S	40.6	[illegible].5	0.40**	0.04
		Calf BW	49.7	0.4	0.0	0.0
		Cow WWLS	49.8	0.1	0.0	0.0
		Cow ADG C-S	50.0	0.2	-0.03	0.03

** P<0.001
N.B. % Additional variance explained not significant (P<0.05) by introduction of 4th variable in each equation

Table II.4. Phenotypic correlations of milk variable yields with cow and calf factors, Kinsella 1977.

Variables[1]	CA	BW	B-S	Calf ADG B-S	Cow ADG Cow WWLS	Ave. Milk
Ave. Milk	.01	.41	.63	.06	-	-
June Milk	.03	.31	.48	.02	-.01	-
Sept. Milk	-.02	.41	.62	.09	.01	-
Ave. BF	.0[illegible]	.42	.56	.07	.04	.86
June BF	-.0[illegible]	.30	.35	.05	.06	-
Sept. BF	.0[illegible]	.42	.64	.09	.01	-
Ave. PROT.	.01	.33	.58	.03	-	.92
June PROT.	-	.22	.43	-	.03	-
Sept. PROT.	.03	.37	.60	.06	.03	-
Ave. LACT.	.03	.40	.60	.09	.05	.95
June LACT.	.07	.28	.42	.04	.07	-
Sept. LACT.	-.02	.40	.60	.11	.02	-

[1] Variables defined in Chapter I.
- = not computed

reported correlations of 0.63 between ewe's milk yield and lamb preweaning ADG.

Similarly, calf age in this study accounted for a significant proportion of the additional variance (Table II.3, Equations 1a,b,c and d). These results suggest that older, more vigorous calves increase their capacity for milk as total energy requirements increase. However, results do not indicate at what point in the calf's preweaning period the demand for milk decreases as forage intake increases. The correlation between calf age and milk yield was low and not significant (Table II.4, r= 0.03). Interpretation of the effect of calf age however if difficult, as this factor may be interpreted to mean either days in lactation of the dam or size due to growth of the calf.

Calf sex, birthweight and cow weight changes during gestation and lactation accounted for a small proportion of the additional variance over and above A, B and A x B in each of the milk variables (Table II.2). In Table II.3 however, calf sex demonstrated a more significant (P<0.05) association with milk yield variables when it was forced to enter the third step of the equations.

The foregoing analyses demonstrated that each of the independent variables accounted for approximately as much variance in one dependent milk variable as in another. The high correlations between average milk yields (Table II.4, r= 0.9) and constituent yields, and the similar association between the cow and calf factors and each of the milk variables suggest that one measurement of either a milk yield variable or constituent yield variable is likely a sufficient indicator of the association between milk traits and cow or calf variables. Because of the technical difficulties involved in the determination of constituent percentages, milk yield alone would serve as an accurate predictor for all milk traits.

The preceding equations provide an indication of the major contributing factors influencing milk and constituent yields. They strongly [illegible] that age and breed of dam and calf preweaning growth are highly associated with milk yield.

They also indicate that cow weight changes and calf birthweight, although influenced by breed and age of dam effects, have little association with lactation performance. Further examination of these factors follows in the individual multiple regressions performed.

The remaining analyses determined the specific effects of individual cow and calf variables on the dependent milk variables of average, June and September yields for 1976 and 1977.

Tables II.5 and II.6 show effects of calf sex, age, birthweight, cow winter weight loss and summer weight change from calving to weaning at approximately 150 days of lactation on average daily milk yields for both years.

Effect of Age and Breed of Dam

When forced to enter the equation first, A, B and A x B interaction together accounted for 43.4 and 43.0% of the total variance in average daily milk yields in 1976 and 1977 respectively. As indicated in Table II.2, dam age alone accounted for 24.6% and breed, 17.5% of additional variance.

Earlier analyses (Table II.1.) suggested there is a confounding effect exerted by age and breed of dam on calf birthweight, cow winter weight loss and cow ADG from calving to September. These results agree with reports of Singh *et al.*, (1971), Fahmy and Lalande (1973) and Smith *et al.*, (1976).

Many authors report significant effects of dam age on milk production. This factor was discussed in some detail in the preceding chapter.

Jeffery (1971), using a similar analysis, found that the effects of cow age alone accounted for 10.5 and 4.6% of the variance in milk yield. Breed of dam alone explained a significant 17 and 33% of the variance in average daily milk yield each year over the effects of calf and cow age in his study.

Gleddie and Berg (1968) estimated that 82.5% of the variance in milk yield was associated with breed of dam effects. However, this high estimate has not been reported in any other literature reviewed.

Table 12.5. Regression of average daily milk yield (Kg/day) on individual cow and calf variables, Kinsella 1976.

Variable of Interest	Equation	Order of Forced Variables	Regression Coefficient for Variable of Interest b (Kg/day)	SEb	Total Variance Explained R^2 x 100 (%)	Additional Variance Explained by Variable of Interest after Forcing other Variables (%)[5]
I. 1976						
Sex of Calf[1]	1. a)	S		-	0.23	-
	b)	A, B, AxB, S		-	43.43	0.02
	c)	A, B, AxB, CA, S	-	-	44.22	0.78
Calf Age[2]	2. a)	CA	-	0.01	-	-
	b)	A, B, AxB, CA	-	0.01	44.19	0.78
	c)	A, B, AxB, S, CA	-0.01	0.01	44.22	0.02
Calf Birthweight[3]	3. a)	BW	0.13	0.02	20.22***	-
	b)	A, B, AxB, BW	0.05	0.02	44.95**	1.52
	c)	A, B, AxB, S, CA, BW	0.05	0.02	45.39*	1.17
Cow ADG from Calving to September[4]	4. a)	Cow ADG C-S	-0.79	0.27	4.03**	-
	b)	A, B, AxB, Cow ADG	-	0.[illegible]	44.44	0.25
	c)	A, B, AxB, S, CA, Cow ADG	[illegible]0.39	0.33	44.63	0.41
Cow Winter Weight Loss[4]	5. a)	WWLS	-0.01	-	4.26**	-
	b)	A, B, AxB, WWLS	-0.01	-	44.47*	0.28
	c)	A, B, AxB, S, CA, WWLS	-0.01	-	44.90*	0.68

[1] non-continuous variable
[2] days
[3] Kg
[4] Kg/day
[5] A, B, AxB accounted for 43.41% of total variance in 1976; A, B, AxB, S, CA accounted for 44.22% of total variance.
* $P<0.05$
** $P<0.01$
*** $P<0.01$

Table II.6. Regression of average daily milk yield (Kg/day) on individual cow and calf variables, Kinsella 1977.

Variable of Interest	Equation	Order of Forced Variables	Regression Coefficient for Variable of Interest b (Kg/day)	SEb	Total Variance Explained $R^2 \times 100$ (%).	Additional Variance Explained by Variable of Interest after Forcing other Variables (%)[5]
I. 1977						
Sex of Calf[1]	1. a)	S	-	-	0.14	-
	b)	A, B, AxB, S	-	-	43.11	0.09
	c)	A, B, AxB, CA, S	-	-	43.12	0.01
Calf Age[2]	2. a)	CA	-	0.01	0.11	-
	b)	A, B, AxB, CA	-	0.01	43.03	0.01
	c)	A, B, AxB, S, CA	-	0.01	43.12	0.09
Calf Birthweight[3]	3. a)	BW	0.14	0.02	21.00***	-
	b)	A, B, AxB, BW	0.04	0.02	44.27**	1.25
	c)	A, B, AxB, S, CA, BW	0.04	0.02	44.31*	1.19
Cow ADG[4] Calving to September[4]	4. a)	Cow ADG C-S	-0.30	0.45	0.20	-
	b)	A, B, AxB, Cow ADG	-0.67	0.41	43.77**	0.75
	c)	A, B, AxB, S, CA, Cow ADG	0.77	0.43	43.99	0.87
Cow Winter Weight Loss[4]	5. a)	WWLS	0.01	-	2.62**	-
	b)	A, B, AxB, WWLS	-	-	43.34	0.32
	c)	A, B, AxB, S, CA, WWLS	-	-	43.43	0.31

[1] non-continuous variable
[2] days
[3] Kg
[4] Kg/day
[5] A, B, AxB accounted for 43.02% of total variance in 1977; A, B, AxB, S, CA accounted for 43.1[illegible]% of total variance.
* P<0.05
** P<0.01
*** P<0.01

In the present study, the addition of calf sex (S) and age (CA) to the forced variables each year accounted for only 0.1 and 0.8% of the variance over and above A, B and A x B. All these factors accounted for respectively 44.2 and 43.1% of the total variance in 1976 and 1977.

Effect of Sex of Calf

Sex of calf accounted for only 0.23% (1976) and 0.14% (1977) of the total variance in average daily milk yield. Following the introduction of A, B, A x B and CA, calf sex still accounted for little of the variance. Because calf sex was treated as a non-continous variable with no numerical value assigned to it, the regression coefficients computed [illegible] difference between male and female calves.

[illegible]illa *et al.*, (1974) reported that calf sex was not [illegible]ficantly associated with milk production while Rutledge *et al.*, (1970) found that females took more milk than males. Neidhardt *et al.*, (1979) however found that the sex of calf exerted more influence on milk yield than age of dam or the dam's body weight at calving.

Peschiera (1966) reported correlations of 0.6 between calf sex and average daily milk and noted that male calves were more vigorous sucklers than females. Richardson *et al.*, (1977) found that when milk yields were corrected for birthweight, sex did not have as strong an effect. Marshall *et al.*, (1976) found that sex had no significant effect on milk production although the breed of dam x sex of calf interaction was significant.

Although results in published reports vary considerably regarding the significance of sex of calf on milk yield, most agree that males, because of their larger size, tend to suckle more frequently than females.

Effect of Calf Age

Calf age (or days in lactation of the dam) in September did not account for a significant percentage of additional variance in average daily milk yields each year. The regression coefficients also indicate no association (b=0) between calf age and milk yield (Tables II.5 and II.6) unlike the results using stepwise regressions of combined cow and calf factors. Milk yield and calf age were not significantly correlated with r values which averaged 0.03 (Table II.4).

The results of this study do not agree with those reported by Rutledge *et al.*, (1971), Neville *et al.*, (1974), Marshall *et al.*, (1976) and Neidhardt *et al.*, (1979). These workers found that age of calf significantly affected milk production and generally exerted a quadratic effect. Neville *et al.*, (1976) reported that a 1 day increase in calf age was associated with 0.014 Kg/day increase in milk production. Both Marshall *et al.*, (1976) and Neidhardt *et al.*, (1979) noted that milk estimates decreased as calf age increased, indicating a decline in milk production as lactation progressed. Similarly, Gleddie and Berg (1968) computed a regression of milk on day of lactation (age of calf) of 0.02 Kg with a significant correlation of -0.46.

No differences in average milk yield were reported by Richardson *et al.*, (1977) when calves were weaned at 150 rather than 240 days. However, cows with early-weaned calves were heavier and gave birth to heavier calves the following year because a long dry period permitted body weight to increase. Richardson *et al.*, (1977) did not specify the advantages of the latter system.

Effect of Calf Birthweight

Calf birthweight accounted for 20.2% (1976) and 21.0% (1977) of the variance (P<0.01) when all other variables were ignored. A 1 Kg increase in BW was associated with a 0.13 Kg/day increase in daily milk yield. After main effects were forced to enter the equation first, BW accounted for an additional 1.17 and 1.19% of the variance, suggesting that the combined effects of A, B, A x B and S removed a large proportion of the variance associated with calf birthweight.

Although calf birthweight and milk yield had moderately high correlations of 0.5 (P<0.01), similar to those computed by Rutledge *et al.*, (1971), increasing birthweight by crossbreeding and selection is not a favourable method for increasing milk production. The incidence of dystocia is widely reported (Smith *et al.*, 1976) when birthweight is increased. This factor will be discussed in Chapter III.

However, results suggest that the effects of age and breed of dam and calf sex confound the individual effect of birthweight as a factor which influences milk production. Richardson *et al.*, (1979) demonstrated with regression analysis that milk increased with cow weight at calving and with calf birthweights, both of which are reflections of breed and age of dam. Rutledge *et al.* (1971) noted that calves with higher birthweight consumed more and were more vociferous. However, these authors contended this was more related to an overall larger size than birthweight *per se*.

Effect of Cow Average Daily Gain from Calving to September

Cow ADG during lactation accounted for only 4.0% (1976) and 0.2% (1977) of the total variance when all other variables were ignored. It accounted for less than 1.0% each year after the introduction of main effects. The b coefficient prior to the introduction of any variable for 1976 indicated a negative association between the milk and cow daily gain. The correlation between the two variables was low and negative.

In efficiency studies with dairy cattle, Morris and Wilton (1976) observed that dairy cows that gained the most weight while lactating were least efficient. Most workers reported that cow weight loss increased with milk produced, suggesting that for high-producers, milk yield is maintained at the expense of body weight (Jeffery *et al.*, 1971; Hohenboken *et al.*, 1973 and Niedhardt *et al.*, 1979). McGinty and Frerichs (1971) however found that among crossbred Hereford cows, those producing more milk did not necessarily lose the most weight. Economides *et al.*, (1973) found that this factor is heavily influenced by feeding as cows that were fed only to maintenance lost more weight and suffered a drastic reduction in milk yield compared to others on a high plane of nutrition.

Richardson *et al.*, (1977) found that although weight change during lactation was negatively related to milk in the first 35 days, it had no significant effect from 36 to 91 days post-partum. These workers found that fat content increased five weeks after calving with an increase in cow weight post-partum ($r = 0.2$, $P<0.05$). They attribute the BF% increase to plane of nutrition rather than normal lactation trends for BF% which increased several weeks post-partum.

Effect of Cow Winter Weight Loss

The results of this study indicated little association and relationship in this study of milk yields with winter weight loss from October of the preceding year to calving. Before the introduction of main effects, cow weight accounted for 4.3 and 2.6% of the variance in 1976 and 1977 respectively, but less than 1% after the main effects were accounted for. The b coefficients were slightly negative but not significant.

Factors Influencing June and September Yields

Tables II.7 through II.10 present ordered regressions of June and September milk yields on individual cow and calf variables for both years. The procedure involved in the following regressions is as described for average milk yield. As results for 1976 were similar to those for 1977, only 1977 figures are discussed.

Table II.7. Regression on June milk yield (Kg/day) on individual cow and calf variables, Kinsella 1976.

Variable of Interest	Equation		Order of Forced Variables	Regression Coefficient for Variable of Interest b (Kg/day)	SEb	Total Variance Explained R^2 x 100 (%)	Additional Variance Explained by Variable of Interest after Forcing other Variables (%)[4]	F
I. 1976								
Sex of Calf*	1.	a)	S	-0.09	-0.05	2.35	-	0.48
		b)	A,B,AxB,S	0.05	0.09	28.29	0.08	0.22
		c)	A,B,AxB,CA,S	0.05	0.03	28.70	0.49	0.17
Calf Age (June)[1]	2.	a)	CA	-0.0	-0.003	-	-	-0.002
		b)	A,B,AxB,CA	-0.01	-0.07	28.63	0.42	1.13
		c)	A,B,AxB,S,CA	-0.01	-0.68	28.70	-	1.07
Calf Birthweight[2]	3.	a)	BW	0.13	0.37	13.95	-	33.06
		b)	A,B,AxB,CA	0.04	0.12	29.00	0.80	2.13
		c)	A,B,AxB,S,CA,BW	0.04	0.11	29.36	0.66	1.70
Cow ADG[3] from calving to June	4.	a)	Cow ADG C-J	0.25	0.14	2.75	-	4.32
		b)	A,B,AxB,Cow ADG	0.17	0.10	29.06	0.85	2.27
		c)	A,B,AxB,CA,S, Cow ADG,J-S	0.15	0.09	29.28	0.59	1.56
Cow Winter[2] Weight Loss	5.	a)	WWLS	0.01	0.19	3.59	-	7.60
		b)	A,B,AxB,WWLS	-0.002	-0.05	28.30	0.09	0.24
		c)	A,B,AxB,CA, S,WWLS	-0.001	-0.02	28.71	0.01	0.05
Calf ADG Birth to June[3]	6.	a)	Calf ADG BJ	0.62	0.39	38.68	-	128.65
		b)	A,B,AxB, Calf ADG,J-S	0.56	0.46	46.23	18.02	63.34
		c)	A,B,AxB,CA,S, Calf ADG,J-S	0.58	0.46	47.44	18.75	66.69

* Non-continuous variable - no value assigned
[1] Day
[2] Kg
[3] Kg/day
[4] A, A, AxB explained 28.21% of variance; A, B, AxB, CA, S explained 28.70% of variance.

Table II.8. Regression of June milk yield on cow and calf variables, Kinsella 1977.

Variable of Interest	Equation	Order of Forced Variables	Regression Coefficient for Variable of Interest b (Kg/day)	SEb	Total Variance Explained $R^2 \times 100$ (%)	Additional Variance Explained by Variable of Interest after Forcing other Variables (%)[5]	F
I. 1977							
Sex of Calf[1]	1. a)	S	-0.04	0.14	-	-	0.06
	b)	A,B,AxB,S	-0.05	0.13	30.67	0.06	0.18
	c)	A,B,AxB,CA,S	-0.06	0.13	31.02	0.08	0.23
Calf Age[2]	2. a)	CA	-	0.01	-	-	0.11
	b)	A,B,AxB,CA	0.01	0.01	30.94	0.27	0.81
	c)	A,B,AxB,S,CA	0.01	0.01	31.02	0.17	0.17
Calf Birthweight[3]	3. a)	BW	0.16	0.03	14.93	-	38.62
	b)	A,B,AxB,BW	0.06	0.03	38.10	1.43	4.35
	c)	A,B,AxB,CA,S,BW	0.07	0.03	32.56	1.54	4.66
Cow ADG from Calving to September[4]	4. a)	Cow ADG C-S	0.45	0.23	1.68	-	3.77
	b)	A,B,AxB, Cow ADG C-S	-0.30	0.24	31.18	0.51	1.54
	c)	A,B,AxB,CA,S, Cow ADG C-S	-0.25	0.27	31.32	0.30	0.91
Cow Winter Weight Loss[3]	5. a)	WWLS	0.01	-	2.92	-	6.62
	b)	A,B,AxB,WWLS	-	-	30.67	-	0.04
	c)	A,B,AxB,CA, S,WWLS	-	-	31.03	-	0.05
Calf ADG from Birth to June[4]	6. a)	Calf ADG B-J	6.90	0.60	38.18	-	135.85
	b)	A,B,AxB, Calf ADG,J-S	56.20	0.70	48.96	18.29	73.81
	c)	A,B,AxB,CA,S, Calf ADG,J-S	5.[illegible]	0.70	49.40	18.38	74.14

[1] non-continuous variable
[2] days
[3] Kg
[4] Kg/day
[5] A, B, AxB explained 30.67% ; A, B, AB, CA, S explained 31.02%.

Table II.9. Regression of September milk yield on cow and calf variables, Kinsella 1976.

Variable of Interest	Equation	Order of Forced Variables	Regression Coefficient for Variable of Interest b (Kg/day)	SEb	Total Variance Explained $R^2 \times 100$ (%)	Additional Variance Explained by Variable of Interest after Forcing other Variables (%)[5]	F
I. 1976							
Sex of Calf[1]	1. a)	S	-0.17	0.12	0.90	-	1.99
	b)	A,B,AxB,S	-0.04	0.09	45.11	0.04	0.15
	c)	A,B,AxB,CA,S	-0.05	0.09	45.97	0.86	0.24
Calf Age[2]	2. a)	CA	-0.001	0.02	0.07	-	4.71
	b)	A,B,AxB,CA	-0.012	0.02	45.90	0.83	2.90
	c)	A,B,AxB,S,CA	-0.012	0.01	45.97	0.07	2.97
Calf Birthweight[3]	3. a)	BW	0.14	0.02	17.60	-	43.76
	b)	A,B,AxB,BW	0.06	0.02	46.72	1.65	5.84
	c)	A,B,AxB,CA,S,BW	0.05	0.02	47.18	1.22	4.31
Cow ADG from June to Sept.[4]	4. a)	Cow ADG J-S	0.72	0.22	5.07	-	10.91
	b)	A,B,AxB,Cow ADG, J-S	0.10	0.27	45.14	0.07	0.23
	c)	A,B,AxB,CA,S Cow ADG, J-S	0.13	0.24	46.08	0.12	0.41
Cow Winter Weight Loss[4]	5. a)	WWLS	0.01	0.003	3.00	-	6.30
	b)	A,B,AxB,WWLS	-0.01	0.003	47.42	2.35	8.43
	c)	A,B,AxB,CA,S WWLS	-	-0.22	47.81	1.64	6.61
Calf ADG J-S[4]	6. a)	Calf ADG J-S	3.32	0.37	28.70	-	82.15
	b)	A,B,AxB, Calf ADG J-S	1.67	0.42	49.26	4.19	15.60
	c)	A,B,AxB,CA,S Calf ADG J-S	2.55	0.04	53.22	7.26	29.00

[1] non-continuous variable
[2] days
[3] Kg
[4] Kg/day
[5] A, B, AxB explained 45.07% of variance; A, B, AxB, CA, S : 45.97%.

Table II.10. Regression of September milk yield on cow and calf variables, Kinsella 1977.

Variable of Interest	Equation		Order of Forced Variables	Regression Coefficient for Variable of Interest b (Kg/day)	SEb	Total Variance Explained $R^2 \times 100$ (%)	Additional Variance Explained by Variable of Interest after Forcing other Variables (%)[5]	F
I. 1977								
Sex of Calf[1]	1.	a)	S	-0.10	0.10	0.42	-	1.01
		b)	A,B,AxB,S	-0.07	0.08	46.86	0.18	0.77
		c)	A,B,AxB,CA,S	-0.06	0.08	47.77	0.15	0.64
Calf Age[2]	2.	a)	CA	-0.02	0.01	1.40	-	3.[illegible]0
		b)	A,B,AxB,CA,	-0.01	-	47.62	0.94	4.06
		c)	A,B,AxB,S,CA	-0.01	-	47.77	0.91	3.92
Calf Birthweight[3]	3.	a)	BW	0.13	0.02	19.33	-	57.32
		b)	A,B,AxB,BW	0.04	0.02	47.69	1.01	4.37
		c)	A,B,AxB,CA,S,BW	0.03	0.02	48.46	0.69	3.00
Cow ADG Calving to September[4]	4.	a)	Cow ADG J-S	-0.81	0.40	1.66	-	4.40
		b)	A,B,AxB,Cow ADG J-S	-0.19	0.34	46.76	0.10	0.33
		c)	A,B,AxB,CA,S Cow ADG, J-S	-0.36	0.35	48.03	0.25	1.11
Cow Winter Weight Loss[4]	5.	a)	WWLS	0.01	-	1.35	-	3.29
		b)	A,B,AxB,WWLS	-0.01	-	47.60	0.92	3.98
		c)	A,B,AxB,CA,S WWLS	-0.01	-	48.65	0.88	3.84
Calf ADG J-S[4]	6.	a)	Calf ADG J-S	5.25	0.48	33.44	-	120.58
		b)	A,B,AxB, Calf ADG J-S	3.21	0.53	54.04	7.36	36.19
		c)	A,B,AxB,CA,S Calf ADG J-S	4.07	0.56	57.62	9.85	52.05

[1] non-continuous variable
[2] days
[3] Kg
[4] Kg/day
[5] A, B, AxB explained 46.68% of variance; A, B, AxB, CA, S : 47.77%.

The effects of A, B and A x B accounted for 28.2 and 46.7% for 1977 June and September milk yields respectively. The addition of calf sex and age to the equation accounted for a small amount of additional variance, but both showed little association.

As demonstrated in Table II.4, correlations between dam breed and milk variables were generally higher for September. This may suggest that the effect of breed of dam exerts a stronger influence on persistency of milk over the course of the lactation period. The milking potential of the range cows cannot be realized if the calf's capacity for ingestion is limited in the early stages of lactation.

The association of calf birthweight with both June and September yields was similar, although correlations indicated a stronger relation between September yields and birthweight (Table II.4). The simple regression coefficients were highly significant (P<0.001). Every 1 Kg increase in birthweight resulted in an average increase of 0.14 Kg/day in average June or September milk yield. This may suggest that the phenotypic effects of birthweight, confounded by age and breed of dam, have a persistent association with milk variables.

Cow weight changes before and after calving accounted for little of the variation in either June or September milk yields after the main effects were accounted for. Cow ADG from calving to June had a positive association with June milk, but b coefficients were negative when cow ADG from calving to September was regressed on 1977 September milk yield.

As expected, calf ADG during the preweaning period had a very high association with both June and September yields, accounting for 9.85 and 18.38% of the additional variance over main effects. The b coefficients were also high and significant, but were lower for September yields than for June.

D. CONCLUSIONS

Data from a milking experiment were collected to examine various factors affecting lactation performance of Hereford, Beef-Synthetic, Dairy-Beef and Dairy-Synthetic cows. Regression equations were computed with dependent variables of average, June and September milk yields and constituent yields. Independent cow and calf factors examined were cow age, breed, age x breed interaction, winter weight loss during gestation, weight change during lactation, calf sex, calf age, birthweight and ADG from birth to September.

Age and breed of dam together exerted major effects on all milk variables, accounting for between 34.0 and 44.0% of the total variation. It is not clear which of age or breed of dam accounted for more of the variation. However, breed of dam was more associated with milk yield variables in September than in June, perhaps suggesting that under range suckling conditons, breed of dam effects are more pronounced later in lactation.

When included in the equation, calf preweaning ADG showed a predictably strong association with all milk yields, accounting for up to 24% of total variation in any one milk or constituent yield variable. The correlation coefficients of calf ADG with any milk yield variable averaged 0.5. Results of the stepwise regressions indicated that every 0.1 Kg/day increase in calf ADG was associated with 0.62 Kg/day increases in average daily milk.

Calf age accounted for a variable proportion of the variation in milk yields depending on the order of variables entered into the equation. In all the equations however, the partial b coefficients were low or negative, contrary to results in other published material.

Calf birthweight did not account for a significant proportion of the variation after accounting for the effects of age, breed, age x breed of dam interaction and calf sex. These effects removed a large proportion of the variation associated with calf birthweight.

Cow weight changes during pregnancy and lactation were not significantly associated with any of the milk yield variables.

A highly significant relationship was found for average milk yields with constituent yields (r=0.9). The similar association between independent cow and calf variables and each of the dependent variables indicated that little additional information is provided by using more than one measure of lactation performance.

III. FACTORS INFLUENCING WEANING WEIGHTS OF RANGE BEEF AND DAIRY-BEEF CALVES

A. INTRODUCTION

Preweaning average daily gain is an important factor affecting the profitability of a cow-calf operation. As weaning weight and preweaning average daily gain are essentially the same measure of growth (Kennedy and Henderson, 1975), and realized response to their selection is favorable (Preston and Willis, 1974), selection for either trait should be incorporated into an efficient beef breeding program.

Among the factors affecting preweaning performance, milk has been shown to exert a major influence on range beef calves. Measurements of milk yield provide a valid prediction of associated response in calf preweaning growth rate (Jeffery and Berg, 1971; Marshall *et al.*, 1976; Spelbring *et al.*, 1977a, 1977b.).

Studies have indicated that the simple correlation between average daily milk yield and weaning weight is only moderately high, suggesting that factors other than milk yield account for additional variation in weaning weight (Gleddie and Berg, 1968; Butson and Berg, 1980). The present study was conducted to examine the influence of milk yield, milk constituent yields and other cow-calf variables on weaning weight.

B. MATERIALS AND METHODS

The breeding plan, general management and method of milk removal were discussed in Chapter I. Data on calf birthweight (BW), calf age (CA), sex (S), weaning weight (WW), cow winter weight loss from October of the preceding year to day of calving (WWLS), cow average daily gain from calving to weaning in October (ADGCO) and September averages of daily yields of milk, butterfat (BF), protein (PROT) and lactose (LACT) were collected from an experiment involving measurements of lactation in range beef cows conducted in 1976 and 1977.

In 1976, 206 cow-calf pairs consisting of 45 Herefords (HE), 102 Beef Synthetics (SY), 26 Dairy-Beef (DB) and 33 Dairy-Synthetics were studied. The following year a total of 242 cow-calf pairs were studied and included 58 HE, 123 SY, 33 DB and 28 DS.

Statistical Analyses

The method of statistical analysis was similar to that outlined in Chapter I for least squares analyses of covariance for unequal subclass numbers. Least squares constants for age of dam (A), breed of dam (B), age x breed of dam interaction (A x B), sex of calf (S) and sex of calf x breed of dam interaction (S x B) were computed and used to calculate least squares means for calf weaning weights.

Stepwise multiple regressions of weaning weight on cow and calf variables for both years were computed using the SPSS REGRESSION as outlined by Nie *et al.*, (1975). The effects of variables on weaning weight were calculated according to two models of regression: a) ignoring the effects of A, B and A x B and allowing variables of interest to enter the equations sequentially based on partial correlations and c) forcing A, B and A x B to enter the equation first. The second method permitted examination of the percent of additional variance explained over and above the effects of A and B.

Ordered multiple regression models of weaning weight on individual milk yields, component yields and cow and calf variables were computed according to the method outlined by Overall and Klett (1972) and described in Chapter II. These permitted the examination of the influence of each of the variables of interest while other variables were either ignored or accounted for in the equations. As the interaction of S x B was not a significant source of variance in the analyses of covariance, this effect was not included in the regression equations. Regressions were computed by: a) ignoring A, B, A x B, S and CA and forcing in the variable of interest; b) forcing the effects of CA and S to enter the equation first before the variable of interest, and c) forcing all of A, B, A x B, CA and S to enter first before forcing in the variable of interest.

C. RESULTS AND DISCUSSION

Analyses of covariance of weaning weight (Table III.1) indicated that for both years the effects of breed and age of dam, and sex and age of calf on weaning weight were highly significant (P<0.01).

Effect of Breed of Dam

Least squares means and standard errors of weaning weight by breed and breed-age groups of dam are presented in Table III.2 for 1976 and 1977. The overall average weaning weights were similar for both years, averaging 192.0±2.0 Kg in 1976 and 193.4±1.7 Kg in 1977.

In 1976 cows in the DS line weaned calves that were significantly heavier than calves in other breed groups (P<0.01), averaging 47.2, 22.3 and 19.3 Kg more than HE, SY and DB calves respectively. However, in 1977, calf weaning weights of the DB line were significantly heavier than those of the HE and SY breed groups (P<0.01), weighing 41.8 and 16.0 Kg more than HE and SY calves respectively. Preliminary analysis of data showed that DB and DS cows produced more milk and were more persistent than those in the HE and SY groups.

Generally calves from dams with dairy breeding tended to exhibit higher weaning weights than those from either straightbred or crossbred beef breeding (Figures III.1 and III.2). These results are similar to others who compared dairy-cross cows with beef cows (Brown *et al.*, 1972) and Wyatt *et al.*, 1977b). Problems were noted by some workers in

Table III.1. Analyses of variance of weaning weight, with age of calf as a covariate.

Source	d.f.		Mean Squares	
	1976	1977	1976	1977
Breed of dam (B)	3	3	10377.9**	11745.7**
Age of dam (A)	3	3	3319.9**	7910.0**
B x A	9	9	233.0	350.5
Sex of calf (S)	1	1	4083.5**	[illegible]411.9**
S x B	3	3	88.8	525.2
Age of calf (AC)	-1	1	40876.6**	4109[illegible].1**
Error	185	221	338.3	312.9
Total	205	241		

** P<0.01

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Table III.2 Least squares means and standard errors of calf weaning weights (Kg) by breed and age groups of dams, Kinsella 1976-1977

	Breed	1976 No. of Calves	1976 Mean	1976 S.E.	1977 No. of Calves	1977 Mean	1977 S.E.
Grand Total	All	206	192.0	2.0	242	193.4	1.7
	HE	45	167.1a	3.3	58	16[illegible].4a	2.8
	SY	102	192.0b	2.2	123	192.2b	1.8
	DB	26	194.8b	6.0	33	208.2c	4.0
	DS	33	214.2c	3.8	28	206.8c	4.2
Age in years							
2	All	75	178.3w	2.4	82	175.2w	2.2
	HE	11	151.0	5.6	18	151.7	4.1
	SY	36	175.9	3.1	35	173.7	3.0
	DB	15	187.1	4.8	20	180.9	4.0
	DS	13	199.5	5.4	8	195.1	8.3
3	All	38	187.0w	3.4	52	194.9x	3.0
	HE	7	182.8	7.0	7	184.9	6.8
	SY	15	184.0	4.8	30	193.0	3.3
	DB	8	197.3	6.6	6	215.5	7.4
	DS	6	203.9	7.9	9	208.4	5.9
4	All	20	203.8x	5.0	26	198.6x	4.7
	HE	5	175.3	8.4	7	172.6	8.7
	SY	10	202.2	5.9	14	194.3	4.8
	DB	2	218.0	13.0	3	213.4	10.3
	DS	3	220.0	10.7	2	214.2	13.2
Mature	All	75	198.1x	5.1	82	204.8x	2.9
	HE	22	178.1	3.9	25	178.8	3.8
	SY	41	[illegible].3	2.9	44	207.7	2.7
	DB	1	177.1	18.8	4	223.4	9.0
	DS	11	223.9	5.8	9	211.7	5.9

a,b,c = Least squares means of weaning weights by breed of dam within years with different alphabetic letters are significantly different (P<0.01).

w,x = Least squares means of weaning weights by age of dam within year with different alphabetic letters are significantly different (P<0.01).

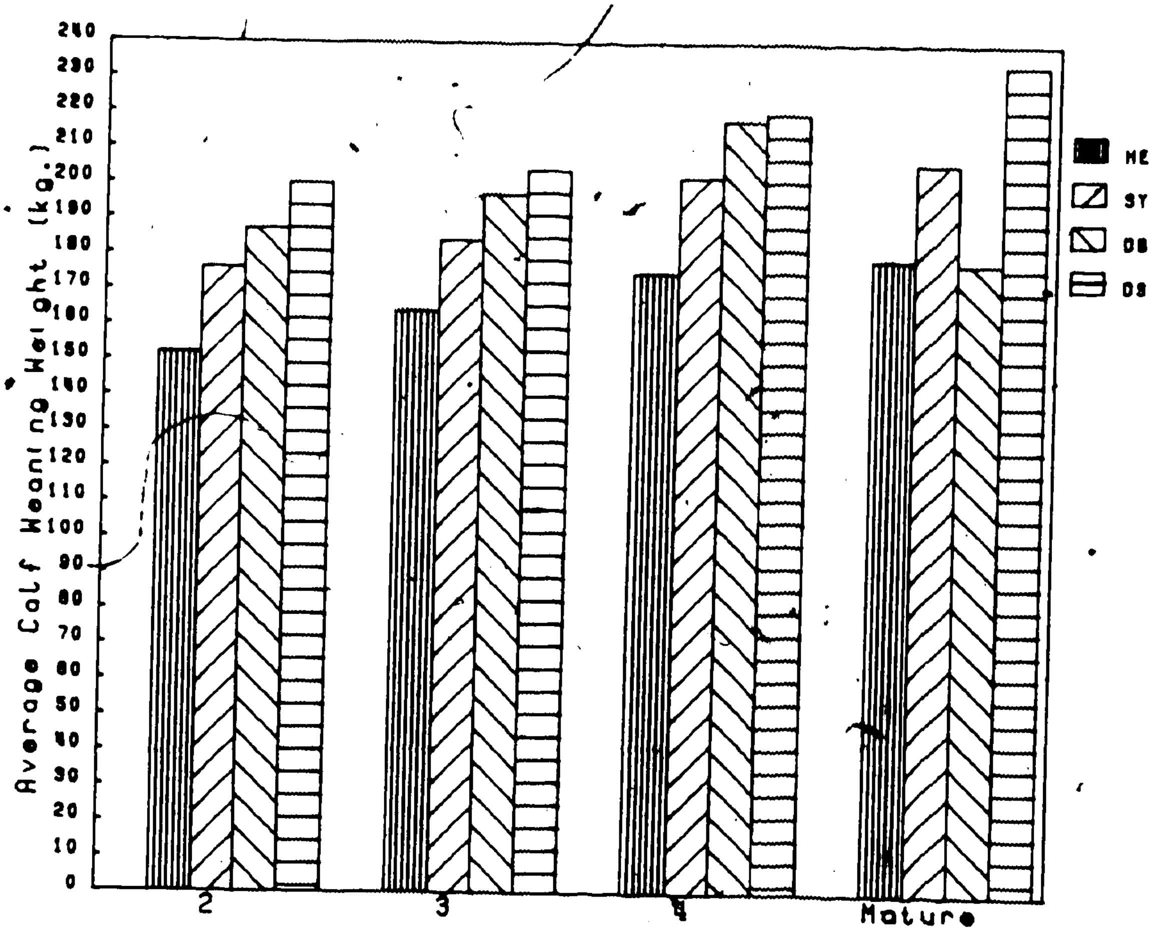

Figure III.1 Average calf weaning weighty by breed and age of dam, Kinsella 1976

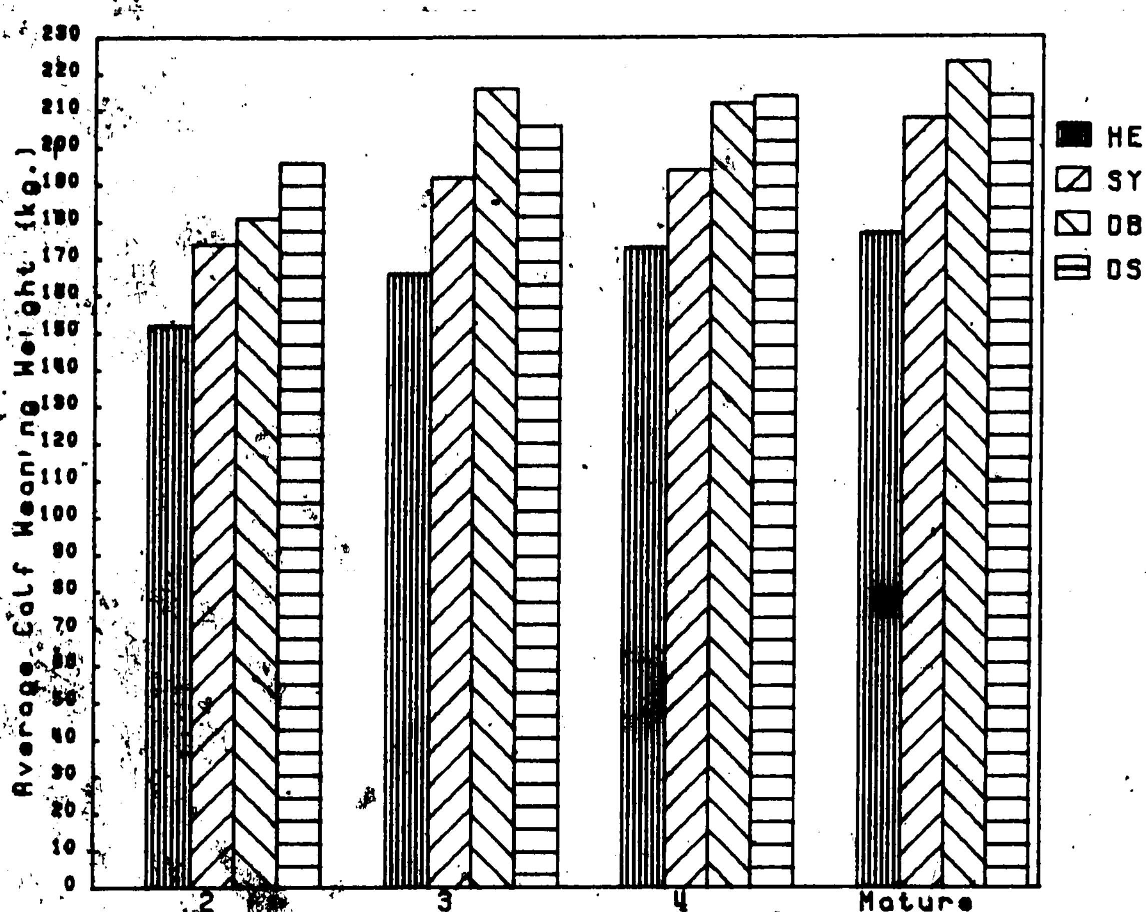

Figure III.2 Average calf weaning weight by breed and age of dam, Kinsella 1977 that high-producing cows tended to have lower reproductive rates (Deutscher and Whiteman, 1971; Bair *et al*., 1972). However, the selection system in the Kinsella experimental herds emphasized regular reproduction. Although this selection may have eliminated the highest milk-producing cows, overall calf crop percentages averaged 84% for SY dams and approximately 78% for HE and DS dams (Berg, 1978), indicating that dairy-cross cows in the present study were able to maintain comparable reproduction to beef cows.

Effect of Age of Dam

Least squares means for breed-age groups of dams (Table III.2) indicated that weaning weight (156 days of age) in 1976 for calves ranged from 151.0±5.6 Kg for calves of the HE 2-year olds to 233.9±5.8 Kg for calves of mature DS dams. In 1977 the range of calf weaning weights (159 days of age) followed a similar pattern of from 151.7±4.1 Kg for calves of 2-year old HE to 223.4±9.0 Kg for calves of mature DB dams.

Although observed differences in adjusted calf weaning weight between the 4-year old and mature dams were small and not significant (P<0.01), increases were noted from 2- to 4-year old dams, similar to the general trend of other published reports. Fahmy and Lalande (1973) reported that Shorthorn calves with maximum weight at weaning were those born to dams averaging 8.2 years of age. Brown *et al*., (1970) found that the quadratic effects of age of dam were highly significant for weaning weight, demonstrating a rapid incline from 3 to 6.5 years, a gradual incline to 8.5 years and a decline to 11 years. Schaeffer and Wilton (1974) observed significant effects ($P<0.05$) of the age of dam with herd performance interaction on calf preweaning ADG and suggested that in herds of low performance an increase in cow age would produce a more noticeable improvement in calf gains than in high performance herds.

In the present study, the overall effect of dam age accounted for a significant ($P<0.01$) source of variance in calf weaning weight (Table III.1). Older cows tended to wean heavier calves, as shown in Table III.2, despite the lack of statistically significant differences between all but the 2-year old age groups in 1977.

Effect of Age x Breed of Dam Interaction

The age x breed of dam interaction (Table III.1) was not a significant source of variance indicating that the differences among breeds were similar for the different ages.

Effect of Sex of Calf

Sex of calf accounted for a highly significant ($P<0.01$) source of variance in weaning weight (Table III.1).

Within each year all males were significantly heavier at weaning ($P<0.01$) than all females (Table III.3). The least squares means of overall weaning weights for males and females (Table III.3) were 197.4±2.5 Kg and 186.7±2.6 Kg respectively in 1976 (a 5.5% difference) and 199.7±2.1 Kg and 187.1±2.2 Kg respectively in 1977 (a 6.3% difference).

Table III.3. Least squares means and standard errors of weaning weight by sex of calf and breed of dam, Kinsella 1976-1977.

		Males			Females			
Year	Breed	No.	Weaning Weight (kg)	S.E.*	No.	Weaning Weight (kg)	S.E.*	Male-Female Weaning Weight Difference (kg)
1976	All	106	197.4	2.5	100	186.7	2.6	10.7**
	HE	25	170.4	3.9	20	163.7	4.7	6.7
	SY	48	196.8	2.9	53	187.1	2.8	9.7
	DB	16	201.7	7.4	14	188.0	6.7	13.7
	DS	17	220.7	4.9	13	207.7	5.6	13.0
1977	All	125	199.7	2.1	117	187.1	2.2	12.5**
	HE	17	169.7	3.8	22	163.1	3.4	6.7
	SY	57	196.6	2.4	53	187.7	2.4	8.8
	DB	23	219.9	5.1	18	196.4	5.1	23.5**
	DS	28	212.5	4.9	24	201.2	5.9	11.3

* S.E. = standard error; ** P<0.01

Results concur with those reported by Bair *et al.*, (1972) and Fahmy and Lalande (1973), but were lower than the 8.8 and 8.3% differences found by Bailey *et al.*, (1975) and Marshall *et al.*, (1976) respectively among calves weaned at 8 months. Preston and Willis (1974) noted that sex differences in weaning weight varied with calf age at weaning and reported that studies conducted on Brahman-cross calves indicated that no sex differences were observed because calves were weaned 90 days before sex hormone influences were manifested.

Effect of Sex of Calf x Breed of Dam Interaction

The sex x breed interaction (Table III.1) did not account for a significant source of variance in calf weaning weight. Smith *et al.*, (1976) reported that less than 1% of the accountable variation in birth weight was explained by the sire breed by sex interaction effect, despite the significant difference ($P<0.01$) at weaning between males and females.

Effect of Age of Calf

The average ages of calves at weaning in 1976 and 1977 were respectively 156.3 and 158.8 days, with a range of from 122 to 180 days in 1976 and 132 to 189 days in 1977.

As expected, calf age at weaning was a highly significant ($P<0.01$) source of variance in weaning weight (Table III.1) and was moderately correlated with weaning weight, with r values of 0.55 and 0.48 (Table III.4) for 1976 and 1977 respectively. Schaeffer and Wilton (1974)

Table III.4. Phenotypic correlations of average milk yield and cow and calf variables: 1976 data coefficients above diagonal (N=206); 1977 data coefficients below diagonal (N=242).

Variables*	Ave. Milk	Cow WWLS	Cow ADGCO	Calf Age	Calf BW	Calf ADGBO	Calf WW
Milk		.21	-.07	-.01	.45	.67	.60
Cow WWLS	.16		.60	.10	.42	.17	.24
Cow ADGCO	-.10	.67		-.23	.26	-.12	-.16
Calf Age	-.03	-.01	-.26		-.14	.17	.55
Calf BW	.46	.38	.16	-.12		.38	.40
Calf ADGBO	.71	.09	-.20	.18	.51		.90
Calf WW	.62	.14	-.22	.48	.93		

*Variables: Cow WWLS=winter weight loss; Cow ADGCO=cow ADG from calving to weaning in October; Calf BW=calf birthweight; Calf ADGBO=calf ADG from birth to weaning in October; Calf WW=calf weaning weight.

r = 0.14 significant at P<0.05; r = 0.18 significant at P<0.01 (d.f. = 200).

cited work that indicated a linear relationship between age at weaning and ADG for 120 to 250 days of age.

Stepwise regressions of weaning weight on cow and calf variables are presented in Table III.5. When weaning weight was regressed sequentially on cow and calf factors (Equation 1a and 1b) calf age accounted for 25.5 and 25.2% of the additional variance over milk variables in 1976 and 1977 respectively, similar to the 21.2% explained by calf age as noted by Lawson (1976). Moreover in both 1976 and 1977 a 1-day increase in calf age was associated with a significant 1.3±0.1 Kg increase (P<0.01) in weaning weight.

In equations 2a and 2b (Table III.5) effects of age of dam (A) , breed of dam (B) and the age x breed (A x B) interaction were forced to enter the regression first. The total of these effects accounted for 47.6 and 45.3% of the variance in weaning weight in 1976 and 1977 respectively. Calf age (CA) however still accounted for 20.4 and 19.5% of additional variance over and above these effects. The partial regression of weaning weight on calf age remained highly significant (P<0.01) with b coefficients of 1.3±0.1 and 1.2±0.1 for 1976 and 1977 respectively.

Despite its marked influence on weaning weight, the average age of calves at weaning can only be effectively increased by either prolonging the preweaning period or by reducing the calving interval. Optimum weaning time would be determined by grazing conditions, potential harmful effects on cow conditions, subsequent reproduction and wintering

Table III.5. Stepwise regressions of weaning weight on cow, calf and milk variables, Kinsella 1976-1977

Equation	Variables entered sequentially into forward regression	% Total variance explained (R^2 x 100)	% Additional variance explained	Partial b	SEb[2]
1. a) 1976	Sept. BF Yield	42.2	--	--	--
	Calf Age[1]	67.7	25.5	1.3**	0.1
	Calf Birthweight	73.1	5.4	--	--
	Ave. Milk	75.4	2.3	--	--
1. b) 1977	Ave. Milk	38.4	--	--	--
	Calf Age[1]	63.6	25.2	1.3**	0.1
	Calf Birthweight	74.7	11.1	--	--
	June Milk	75.9	1.1	--	--
2. a) 1976	A, B, A x B	47.6	--	--	--
	Calf Age[1]	68.0	20.4	1.3**	0.1
	Sept. BF Yield	76.1	8.2	--	--
	Calf Birthweight	78.6	2.5	--	--
2. b) 1977	A, B, A x B	45.3	--	--	--
	Calf Age[1]	64.9	19.5	1.2**	0.1
	Ave. Lactose	75.5	10.6	--	--
	Calf Birthweight	80.7	5.2	--	--

[1] Days
[2] Standard error of b

** $P<0.01$

costs. Bailey *et al.*, (1975) reported that calves weaned at 10 months of age were heavier than those weaned at 8 months ($P<0.05$) but that liveweight gains would be largely affected by grazing conditions and stocking rates. Furthermore, these workers reported that cows suckling their calves lost more liveweight, particularly during the period from weaning to calving.

Effect of Milk Yields and Component Yields

Earlier analyses indicated that simple correlations of average milk yield with component yields of butterfat, protein and lactose were high, ranging from 0.8 to 0.9 for both years (Chapter I). These figures were in agreement with coefficients reported by Gleddie and Berg (1968) and Jeffery and Berg (1971). All milk yield variables in the present study were moderately correlated with weaning weight and averaged 0.60 as indicated for average milk yield in Table III.4. Koch (1972) calculated r values that ranged from 0.5 to 0.8 for average milk weight with weaning weight, similar to estimates reported by Gleddie and Berg (1968) and Marshall *et al.*, (1976).

These relationships may suggest that a measure of association of one milk yield variable with weaning weight would be expected to reflect a similar relationship as another variable. Jeffery and Berg (1971) reported milk yield alone was as adequate as any other single milk variable as a measurement of associated response in preweaning growth rate, and that the addition of milk component yields over milk alone had limited value in increasing the efficiency of predicting calf growth.

The 1976 September BF yield accounted for 42.3% of total variance explained in calf weaning weight (Table III.5). Average milk yield entered the equation after calf age and birthweight, accounting for only 2.3% of the additional variance.

As milk component yields were so highly correlated with milk yields, it is likely that the variation in weaning weight explained by September BF removed a large proportion of the variation in weaning weight accounted for by average milk yield. This also occurs in the 1977 results (Table III.5 Equation 1b) as average daily milk yield entered the regression first, explaining 38.4% of the variance in weaning weight uncorrected for age of calf. However, when calf age entered the equation next, milk yield and calf age accounted for 63.6% of total variance in weaning weight.

These age-corrected values are somewhat lower than those reported by others who studied the effects of milk yield on preweaning ADG. Gleddie and Berg (1968) and Jeffery and Berg (1971) found that average milk yield accounted for approximately 71% and 60% of the variation in calf preweaning ADG respectively. Rutledge *et al*., (1971) noted that on a within herd-year-sex basis, 60% of the variation in 205-day weight was due to the independent effects of the first four months of milk yield. Slen *et al*., (1963) claimed that as no difference was found in protein or butterfat content ($P<0.05$) in five breeds of sheep these constituents had little influence on body weight gain of lambs or its correlation with milk production. All authors reported that the inclusion of milk yields in the later stage of lactation added little to the explained variance in either weaning weight or preweaning ADG.

In equations 2a and 2b (Table III.5) the effects of A, B, A x B were forced to enter the regression first. These effects accounted for 47.6 and 45.3% of the total variation in weaning weight for 1976 and 1977 respectively. Age of calf (CA), September BF and calf birthweight (BW) accounted for 20.4, 8.2 and 2.5% of additonal variation in 1976. Results in 1977 were similar with the exception that average LACT yield replaced September BF as a variable accounting for 10.6% of additional variation.

Ordered multiple regressions of calf weaning weight on individual average milk and component yields were computed for the 1976 and 1977 data and are are presented in Table III.6. Regressions were computed a) without accounting for any main effects; b) after accounting for the influence of S, CA and c) after accounting for the influence of S, CA, A, B and A x B.

Prior to the addition of any other variable, a 1 Kg increase in daily milk yield was associated with a 12.4±1.2 Kg and 11.3±1.3 Kg increase in weaning weight each year respectively. However, after adjusting for the effects of S, CA, A, B and A x B, the regression coefficients decreased to

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Table III.6. Regressions of weaning weight (Kg) on individual milk variables, Kinsella 1976-1977.

Variable of Interest	Equation	Order of Forced Variables*	Regression Coefficient for Variable of Interest b(Kg)	SEb	Total Variance Explained R' x 100 (%)	Additional Variance Explained by Variables Interest after forcing other Variables (%)
I. 1976						
Ave. Milk'	1. a)	Ave. Milk	12.4	1.2	35.9	--
	b)	AC, S, Ave. Milk	12.2	0.8	69.7	34.5
	c)	A, B, A x B, AC, S. Ave. Milk	7.8	1.0	78.1	8.0
Ave. BF Yield'	2. a)	Ave. BF Yield	2.3	0.2	29.9	--
	b)	AC, S, BF Yield	2.2	0.2	63.9	28.7
	c)	A, B, A x B, AC, S. Ave. BF	1.4	0.2	76.4	6.2
Ave. PROT Yield'	3. a)	Ave. PROT Yield	3.4	0.4	32.4	--
	b)	AC, S, PROT Yield	3.4	0.3	66.8	31.6
	c)	A, B, A x B, AC, S, Ave. PROT.	2.1	0.3	76.8	6.7
Ave. LACT Yield'	4. a)	Ave. LACT Yield	2.2	0.2	34.7	--
	b)	AC, S, Ave. LACT Yield	2.1	0.2	66.9	31.6
	c)	A, B, A x B, AC, S, Ave. LACT	1.3	0.2	78.1	7.9
II 1977						
Ave. Milk'	5. a)	Ave. Milk	1.3	1.0	38.4	--
	b)	AC, S, Ave. Milk	11.5	0.7	66.8	38.6
	c)	A, B, A x B, S, Ave. Milk	7.5	0.8	78.1	9.5
Ave. BF Yield'	6. a)	Ave. BF Yield	2.1	0.2	35.3	--
	b)	AC, S, BF Yield	2.1	0.2	62.2	35.0
	c)	A, B, A x B, S, Ave. Milk	1.4	0.2	76.5	9.0
Ave. PROT Yield'	7. a)	Ave. PROT Yield	3.3	0.3	36.4	--
	b)	AC, S, Ave, PROT Yield	3.4	0.2	65.0	37.8
	c)	A, B, A x B, AC, S, Ave. PROT	2.1	0.3	76.2	8.7
Ave. LACT Yield'	8. a)	Ave. LACT Yield	2.1	0.2	37.1	--
	b)	AC, S, Ave. LACT Yield	2.1	0.1	63.9	36.6
	c)	A, B, A x B, AC, S. Ave. LACT	1.4	0.1	77.9	10.4

* AC = Calf Age; S = Calf Sex; A = Age of dam; B = Breed of dam; A x B = Age x Breed of dam interaction

' Kg ' 0.01 Kg

' AC and S accounted for 35.2% and 27.2% of total variance in 1976 and 1977 respectively;
A, B, A x B, AC and S accounted for 70.2% and 67.5% of total variance in 1976 and 1977 respectively

7.8 and 7.5 in each year respectively. Milk yield accounted for an additional 8.0 and 9.5% of total variance over and above all other effects in 1976 and 1977 respectively.

Other workers reported a significant association of milk yield with preweaning growth measurement. Jeffery and Berg (1971) calculated increases of between 0.06 and 0.09 Kg/day in preweaning average daily gain for every Kg increase in the averages of August and October milk yields. For traditional beef breeds and crosses, Marshall *et al.*, (1976) reported rather low responses of 1.5±0.4 Kg at weaning for every Kg increase in milk yield over the 5 Kg/day average. Rutledge *et al.*, (1971) found that every 1 Kg increase in daily milk yield averaged over the first four months of lactation resulted in increases of only 2.5 Kg at weaning.

In equations which accounted for the effects of S and CA, percentage of total variation explained was 35.2 and 27.2% for 1976 and 1977. For S, CA, A, B and A x B, percentage of total variation explained was respectively 70.2 and 67.5% in each year. These effects accounted for somewhat less variation than those reported by Rutledge *et al.*, (1971), who found that year, herd, sex, sires, milk yield and other cow and calf variables accounted for 92.4% of the variation in weaning weight.

Percentage of additional variation explained and regression coefficients for average daily milk constituent yields were similar with respect to association with weaning weight. The average daily BF, PROT and LACT yields explained from 6 to 10% of total variation in weaning weight over and above effects of S, CA, A, B and A x B in both years. A 0.01 Kg increase in each of average component daily yields effected increases in weaning weights of approximately 1.4, 2.1 and 1.3 Kg respectively for both years (Table III.6).

Effect of Cow Winter Weight Loss

The least squares means and standard errors of cow winter weight loss (WWLS) for both years are presented in Table III.7. The means of WWLS from October of the preceding year to post-calving for the relatively mild winters of 1975-1976 and 1976-1977 were 54.9±2.9 and 51.9±2.9 Kg respectively for all cows. Although differences between breed groups were not significant there were significantly different results within the age-breed categories. Between age groups the mature cows demonstrated a significantly ($P<0.05$) higher winter weight loss than younger cows. The noticeable difference between 2-year olds and other age groups in this study reflects the different feeding and management for first-calf heifers as these results are unlike those reported by Deutscher and Whiteman (1971) and Wyatt *et al.*, (1977b). These authors observed that cows with dairy breeding and 2-and 3-year olds lost more weight than did Herefords and older cows.

The correlations of WWLS with weaning weight and milk yield (Table III.4) were low, averaging approximately 0.20 each year. Results concur with those cited by Morris and

Table III.7. Least squares means and standard errors of cow winter weight loss. Kinsella 1976-1977.

	Breed of Dam	Number 1976	Number 1977	WWLS[1] (kg) 1976 Mean	1976 S.E.	1977 Mean	1977 S.E.
Grand Total	All	206	242	54.9ns	2.9	51.9ns	2.9
	HE	45	58	51.5a	4.7	56.3a	4.5
	SY	102	123	55.0a	3.1	52.6a	2.9
	DB	26	33	61.2a	8.7	51.8a	8.4
	DS	33	28	51.9a	5.5	46.7a	6.8
Age in Years							
2	All	75	82	11.9w	3.5	29.3w	4.9
	HE	11	19	16.9	8.1	34.4	6.9
	SY	36	35	11.3	4.5	34.2	4.9
	DB	15	20	4.8	6.9	20.7	11.9
	DS	13	8	24.3	7.7	8.0	13.5
3	All	36	52	62.8x	4.8	47.0x	4.9
	HE	7	7	61.8	10.1	51.3	1.0
	SY	15	30	65.3	7.0	45.7	5.3
	DB	8	6	56.7	9.6	56.0	15.0
	DS	6	9	67.5	11.5	38.4	18.3
4	All	20	26	62.6x	7.2	52.5x	7.5
	HE	5	7	58.0	12.2	54.1	10.9
	SY	10	14	61.4	8.5	53.9	7.7
	DB	2	3	74.8	18.9	53.6	11.3
	DS	3	2	56.0	15.5	48.3	19.9
Mature	All	75	82	82.1y	7.4	77.7y	4.8
	HE	22	25	69.2	5.7	85.4	5.8
	SY	41	44	81.9	4.2	76.6	4.3
	DB	1	4	117.9	27.3	37.1	15.9
	DS	11	9	59.5	8.4	71.9	9.9

ns = Grand total year means within a trait not significantly different ($P<0.05$)
[1] WWLS = cow winter weight loss from October of the preceding year to calving;
a = Least squares means of WWLS by breed of dam within years with different alphabetic letters are significantly different ($P<0.01$)
w,x,y = Least squares means of WWLS by breed of dam within years with different alphabetic letters are significantly different ($P<0.01$)

Wilton (1976) who reported a correlation of 0.14 between calf weaning weight and cow pre-calving weight change.

Ordered regressions of weaning weight on WWLS indicate little association with calf weaning weight (Table III.8) After adjusting for S, CA, A, B and A x B (Table III.8 Equations 1c and 4c) a 1 Kg loss in winter weight was associated with no decrease in 1977 and a decrease of 0.1 Kg in weaning weight in 1976. Moreover, before adjustments WWLS accounted for only 5.8 and 2.1% of the total variation in weaning weight in 1976 and 1977. After adjusting for other effects it did not account for any of the additional variation.

Winter weight loss as it occured in these cows treated alike had neither a significant correlation with milk production nor did it account for a significant proportion of either total or additional variation explained in calf weaning weight. Further investigation is required to determine the effects of various levels of energy supplementation on dams' winter weight losses and growth performance of the suckling calf.

Effect of Cow Average Daily Gain from Calving to Weaning

The least squares means of cow ADG from calving to weaning in October (ADGCO) in 1976 and 1977 were respectively 0.6 and 0.4 Kg/day for all age and breed groups examined (Table III.9). Cows gained significantly ($P<0.01$) less weight per day in 1977, possibly the result of differences in rainfall distribution between years. The SY,

Table III.8. Regression of weaning weight on individual cow and calf variables, Kinsella 1976-1977.

Variable of Interest	Equation	Order of Forced Variables*	Regression Coefficient for Variable of Interest b(Kg)	SEb	Total Variance Explained $R^2 \times 100$ (%)	Additional Variance Explained by Variable of Interest after forcing other Variables (%)[3]
I. 1976						
Cow WWLS[1]	1. a)	Cow WWLS	0.2	0.1	5.8	--
	b)	AC, S, Cow WWLS	0.1	0.1	38.3	3.1
	c)	A, B, AB, AC, Cow WWLS	-0.1	0.1	70.5	0.3
Cow ADGCO[2]	2. a)	Cow ADGCO	-2.6	1.1	2.5	--
	b)	AC, S, Cow ADGCO	-0.4	1.0	35.3	0.1
	c)	A, B, AB, AC, S,	-1.5	0.8	70.8	0.6
Calf BW[1]	3. a)	Calf BW	2.5	0.4	16.2	--
	b)	AC, S, Calf BW	2.9	0.3	55.9	20.7
	c)	A, B, AB, AC, S, Calf BW	1.5	0.3	73.3	3.1
II. 1977						
Cow WWLS[2]	4. a)	Cow WWLS	0.1	0.1	2.1	--
	b)	AC, S, Cow WWLS	0.1	0.1	29.0	2.2
	c)	A, B, AB, AC, S, Cow WWLS	0.0	0.0	65.2	0.1
Cow ADGCO[2]	5. a)	Cow ADGCO	-3.1	1.0	4.2	--
	b)	AC, S, Cow ADGCO	-1.1	0.9	27.3	4.8
	c)	A, B, AB, AC, S,	-1.0	0.7	65.5	0.3
Calf BW[1]	6. a)	Calf BW	2.9	0.3	27.7	--
	b)	AC, S, Calf BW	3.3	0.3	57.7	30.9
	c)	A, B, AB, AC, S, Calf BW	1.9	0.3	71.8	6.7

** AC = Calf Age; S = Calf Sex; A = Age of dam; B = Breed of dam; A x B = Age x Breed of dam interaction.

[1] Kg
[2] 0:01 kg
[3] AC and S accounted for 35.2% and 27.2% of total variance in 1976 and 1977 respectively; A, B, A x B, AC and S accounted for 70.2% and 67.5% of total variance in 1976 and 1977 respectively.

Table III.9. Least squares means and standard errors of cow average daily gain from calving to October, Kinsella 1976-1977.

	Breed of Dam	Number 1976	Number 1977	ADGCO[1] (kg/day) 1976 Mean	1976 S.E.	1977 Mean	1977 S.E.
Grand Total	All	206	242	0.6**	0.0	0.4**	0.0
	HE	45	58	0.6a	0.0	0.5a	0.0
	SY	102	123	0.6a	0.0	0.4b	0.0
	DB	26	33	0.8b	0.1	0.3b	0.1
	DS	33	28	0.5a	0.0	0.4b	0.0
Age in Years							
2	All	75	82	0.5w	0.0	0.3w	0.0
	HE	11	19	0.6	0.0	0.4	0.0
	SY	36	35	0.5	0.0	0.3	0.0
	DB	15	20	0.4	0.0	0.2	0.1
	DS	13	8	0.4	0.1	0.2	0.1
3	All	36	52	0.6x	0.0	0.4x	0.0
	HE	7	7	0.6	0.1	0.5	0.1
	SY	15	30	0.7	0.1	0.4	0.0
	DB	8	6	0.6	0.1	0.4	0.1
	DS	6	9	0.6	0.1	0.4	0.1
4	All	20	26	0.7y	0.1	0.5x	0.0
	HE	5	7	1.0	0.1	0.5	0.1
	SY	10	14	0.7	0.1	0.8	0.1
	DB	2	3	0.9	0.1	0.5	0.1
	DS	3	2	0.6	0.1	0.5	0.1
Mature	All	75	82	0.7y	0.1	0.4x	0.0
	HE	22	25	0.6	0.0	0.6	0.0
	SY	41	44	0.6	0.0	0.4	0.0
	DB	1	4	1.2	0.2	0.4	0.1
	DS	11	9	0.5	0.1	0.4	0.1

[1] Cow ADGCO = cow average daily gain from calving to weaning in October;
a,b,c = Least squares means of Cow ADGCO by breed of dam within years with different alphabetic letters are significantly different (P<0.01)
w,x,y = Least squares means of Cow ADGCO by age of dam within years with different alphabetic letters are significantly different (P<0.01)
** significantly different at P<0.01

DB and DS groups demonstrated a tendency to gain less than HE dams. Deutscher and Whiteman (1971) and Wyatt *et al.*, (1977a) noted that as a larger proportion of feed is converted to milk and not to body fat by the high milk-producing crossbreds, these cows did not regain winter weight loss as noticeably as purebred Angus and Hereford cows.

There was a tendency for cows that exhibited more weight loss during pregnancy to gain more per day during lactation between age and breeds, similar to trends observed by Wyatt *et al.*, (1977b).

Phenotypic correlations (Table III.4) of cow ADGCO with milk and weaning weight were low and negative at respectively -0.07 and -0.16 in 1976 and respectively -0.10 and -0.10 and -0.20 in 1977, similar to values reported by Hohenboken *et al.*, (1973) and Koch (1972) (Table III.4). These results suggested that cow weight gain during lactation may be slightly at the expense of milk production. Morris and Wilton (1976) noted that although the magnitude depended on the particular stage of lactation considered, the relationship between milk production and body weight change during lactation was negative as was the relationship between calf weaning weight and weight change of the lactating cow.

Ordered regressions of weaning weight on cow ADGCO (Table III.8 Equations 2a, 5a) indicated that as an individual variable, cow ADGCO accounted for only 2.5 and

4.2% of the total variation explained in weaning weight in 1976 and 1977 respectively, similar to the 1% of variation explained by cow weight and condition as noted by Marshall *et al.*, (1976). After the introduction of the effects of S and CA, and subsequently S, CA, A, B and A x B, (Table III.8, Equations 2b, 2c, 5b, 5c) the percent of additional variation explained over and above these effects remained small for both years.

For every 0.1 Kg increase in cow ADG during lactation, calf weaning weight showed a decrease of 1.5 and 1.0 Kg in 1976 and 1977 respectively (Table III.8 Equations 2c and 5c) after other effects had been forced to enter the regression first. Singh *et al.*, (1970) calculated that a 1% loss in cow weight during suckling was associated with an increase of from 0.14 to 1.09 Kg in weaning weight, suggesting that cows producing more milk had faster gaining calves and lost weight while nursing them.

Morris and Wilton (1976) suggested that heavier weaning weights were derived from cows which lost more body weight during lactation. In the present study however, cow ADGCO accounted for little of either total or additional variation explained in weaning weight. This factor may indicate that cow summer weight changes are confounded with the effects of age and breed of dam which accounted for a large proportion of the variation in weaning weight.

Effect of Calf Birthweight

Least squares means of calf birthweight for 1976 and 1977 were 35.4±0.4 and 38.0±0.4 Kg respectively overall, ranging from 29.9±1.2 Kg for calves of 2-year old HE dams to 44.2±1.2 Kg for calves of mature DS dams. The difference between years was significant ($P<0.01$) with calves weighing approximately 2 Kg more at birth in 1977 than in 1976. Although calves of older dams and those with dairy breeding tended to be heavier at birth, differences were consistently significant ($P<0.05$) only between calves of 1-year olds and those born to dams of other age groups. Fahmy and Lalande (1973) reported significantly lighter birth and weaning weights for calves from 2- and 3-year old dams and maximum weights at birth and weaning from cows averaging 7.6 and 8.2 years respectively. Similar trends were noted by Singh *et al.*, (1970), Lawson (1976) and Smith *et al.*, (1976).

Phenotypic correlations of birthweight with weaning weight calculated from the present data were 0.40 and 0.53 in 1976 and 1977 respectively (Table within the range of estimates reported by Rutledge *et al.*, (1971) and Fahmy and Lalande (1973).

Calf birthweight exhibited little association with weaning weight in the regression analysis of adjusted data (Table III.8, Equations 3 and 6) as most of the variation explained was accounted for by the effects of calf sex and age of dam. Calf birthweight accounted for an additional 3.1 and 6.7% of additional variation over the effects of S, CA,

Table III.10. Least squares means and standard errors of calf birthweight, Kinsella 1976-1977.

	Breed of Dam	Number 1976	Number 1977	BW' (kg) Mean 1976	S.E. 1976	Mean 1977	S.E. 1977
Grand Total	All	206	242	35.4**	0.4	38.0**	0.4
	HE	45	58	33.9a	0.7	34.5a	0.6
	SY	102	123	35.2a	0.5	38.1b	0.4
	DB	26	33	34.2a	1.3	39.0b	1.2
	DS	33	28	38.5b	0.8	40.5b	1.0
Age in Years							
2	All	75	82	31.4w	0.5	34.5w	0.7
	HE	11	19	29.9	1.2	31.1	1.0
	SY	36	35	31.8	0.7	35.2	0.7
	DB	15	20	30.6	1.0	37.0	1.7
	DS	13	8	33.4	1.1	34.5	2.0
3	All	36	52	34.3x	0.7	8.0x	0.7
	HE	7	7	32.5	1.5	33.5	1.6
	SY	15	30	34.1	1.0	37.2	0.8
	DB	8	6	33.8	1.4	37.9	2.2
	DS	6	9	36.9	1.7	43.2	2.6
4	All	20	26	37.8y	1.1	39.2x	1.1
	HE	5	7	36.2	1.8	35.5	1.6
	SY	10	14	38.1	1.3	39.1	1.1
	DB	2	3	37.4	2.8	39.1	1.6
	DS	3	2	39.3	2.3	43.2	2.9
Mature	All	75	82	38.2y	1.1	40.4x	0.7
	HE	22	25	37.1	0.8	37.7	0.8
	SY	41	44	36.9	0.6	40.7	0.6
	DB	1	4	34.8	4.0	42.0	2.3
	DS	11	9	44.2	1.2	41.2	1.4

' BW = calf birthweight
a,b = Least squares means of BW by breed of dam within years with different alphabetic letters are significantly different (P<0.01)

** significantly different at P<0.01

A, B and A x B in each year respectively.

After adjusting for other effects a 1 Kg increase in weight at birth effected an increase of 1.5 Kg at weaning in 1976 and 1.9 Kg in 1977, similar to results found by Lawson (1976), Rutledge *et al.*, (1971) and Singh *et al.*, (1970).

Although higher birthweights may be associated with increased preweaning growth response, this advantage is possibly outweighed by the higher incidence of dystocia and reproductive problems. Berg *et al.*, (1978) noted that a reduction in birth weight would be as undesirable as an excessive increase, because increased mortality is associated with both very small and large calves. Rather, concurrent selection for dams with greater pelvic capacity and for fast-gaining bulls who sire calves with moderate birthweights would be recommended for improving weaning weight.

D. CONCLUSIONS

The effects of dam breed and age were highly significant ($P<0.01$) and together accounted for between 45 and 48% of the variation in calf weaning weight each year. Cows with dairy background produced more milk and weaned heavier calves than the Hereford and Beef-Synthetic dams. The greatest difference of age of dam on calf weaning weight in this study was between 2-year olds and older dams.

Age and sex of calf were also significant effects. Age of calf accounted for between 20 and 26% of the variation in calf weaning weight. Regression of weaning weight on calf age was 1.3 Kg/day. There was approximately 6% difference in weight at weaning at approximately 157 days of age between sexes each year.

Measurements of milk yield or associated constituent yields served as good predictors of calf preweaning growth response. Much of the influence of milk was confounded with age and breed of dam. Regression analyses showed that milk yield variables explained a significant 6 to 10% of variation in weaning weight after removing the effects of cow age and breed, and calf age and sex. While measurements of milk constituent yields are useful in determining specific differences between breeds, they accounted for little of the variation in weaning weight over milk yield alone.

The effects of other cow and calf variables were generally small and not significant. Cow winter weight loss during gestation and summer weight gain of the lactating cow had little influence on calf weaning weight. Calf birthweight was moderately correlated with weaning weight. However, as this factor is often associated with high levels of dystocia, selection for increased birthweight is not advisable for increasing weaning weight.

Results indicate that milk and constituent yields are largely influenced by the age and breed of dam. The confounding effect of the breed of dam may be partly due to different inherent growth rate potential between breeds, but this factor requires further investigation.

As the association between milk yield and weaning weight is so significant, the introduction of dairy breeding into the dam line to increase milk yields and subsequent weaning weights may be a viable consideration for a breeding program in a cow-calf operation.

GENERAL SUMMARY AND CONCLUSIONS

The objectives of the present study were to examine differences in lactation trends among four breed groups including purebred Hereford (beef); a synthetic of three beef breeds; a synthetic of dairy and beef breeds; and dairy x beef crossbred cows; and to determine various cow and calf factors influencing lactation performance of range cows and weaning weights of their calves.

An experiment using exogenous oxytocin was conducted to collect milk samples from a total of 448 cows over two years.

Milk extraction using 20 I.U. of oxytocin and teat tubes appeared adequate as a method of measuring a cow's milk yield. Residual milk collected from cows tested was negligible and generally, yields were similar to those reported in the literature.

Samples were analyzed for constituent percentages and cow and calf weights and ages were recorded.

Few studies comparing lactation trends had been conducted on large samples of range beef cattle, and comparison of results was therefore difficult as methods of milk extraction, sample size, breed differences and statistical analyses varied considerably among research reports reviewed.

A more precise indication of specific lactation trends and effects of age and breed of dam would have been possible if cows were separated into breed groups according to exact breed compostion. If a larger number of older cows were available, cow age effects could have been partitioned into 9 age groups for cows ranging in age from 2 to 10 years. Had milk measurements been taken more often during the lactation, the lactation curve would provide more information on changing trends.

In the present study however, the author was concerned with general rather than specific trends and associations; conclusions drawn from this study can be practical and applicable in different environments.

Given the wide range in calf age and unequal numbers of breed of dam and age of dam groups, one would expect a high error term. However, error was considerably reduced in the statistical treatment of data by the method of adjustment for main effects including dam age and breed and calf age and sex.

Lactation Trends

Dams with backgrounds which included Holstein and Brown Swiss breeding yielded more milk and exhibited greater persistency than beef crossbreds and purebred Herefords. Because dairy crossbreds in this experiment were not milked regularly for commercial purposes, they produced considerably less milk than dairy cows used in industry. Commercial dairy cows have been selected for high milk production and the introduction of such breeds into the breeding system at Kinsella has served to increase milk yields among the crossbreds.

However, this factor alone is not the sole reason for increased production. Heterosis may have been a factor that influenced milk production as crossbreds at Kinsella with various beef breed backgrounds yielded more milk than the purebred Hereford dams studied.

Heterosis possibly accounted for the high constituent percentages of butterfat, protein and lactose produced by all the crossbreds. These results paralleled those reported in the literature for crossbred beef cattle, but were higher than for purebred beef cows or traditional dairy cows.

Factors Influencing Milk and Constituent Yields

Regressions on milk and constituent yields indicated that breed and age of dam effects exerted a strong influence on the level of milk trait measured, accounting for up to 44% of the variation in milk yields. Calf preweaning average daily gain (ADG) also exhibited a high association with any one milk yield variable, being associated with 24% of the total variation in yields, ignoring the effects of age and breed of dam.

Factors such as calf birthweight and cow weight changes during pregnancy and lactation did not account for a significant proportion of the variation in any one milk yield variable tested. In the regressions, main effects removed a large proportion of the variation associated with calf birthweight and cow weight changes. Assuming identical management treatment and level of nutrition, these factors are largely a reflection of calf sex and dam age and breed.

Factors Influencing Weaning Weights

As calf preweaning average daily gain is a function of age and weight and was highly associated with milk yields, it was expected that milk and constituent yields would demonstrate a high association with weaning weight corrected for calf age.

As milk yields are influenced by the age and breed of dam, regressions on weaning weight indicated that age and breed of dam accounted for up to 48% of the variance in weight of calf weaned.

Mature cows and dairy crossbreds produced the heaviest calves at weaning. However, beef crossbreds which generally yielded more milk than the Herefords, weaned heavier calves than the Hereford dams, again demonstrating the positive effects of crossbreeding, as well as breed composition.

When the effects of age and breed of dam were accounted for, regressions of weaning weight on milk yield showed that milk accounted for up to 10% of the additional variation in weaning weight ($P<0.05$).

Calf age and sex had moderate effects on weaning weight. Age at weaning however cannot be drastically increased through management without affecting subsequent reproductive performance of the dam.

Calf birthweight and cow weight changes did not significantly influence weaning weights. These effects however, were confounded by age and breed of dam.

Of interest to the producer are factors that can be used to increase herd productivity. Results of this investigation support evidence suggesting that the systematic addition of dairy cattle breeds in a crossbreeding program will positively affect the weight of the weaned calves by increasing milk production of their dams. Combined with selection that emphasizes reproductive performance and high weaning weight, the level of herd productivity can be expected to respond favorably.

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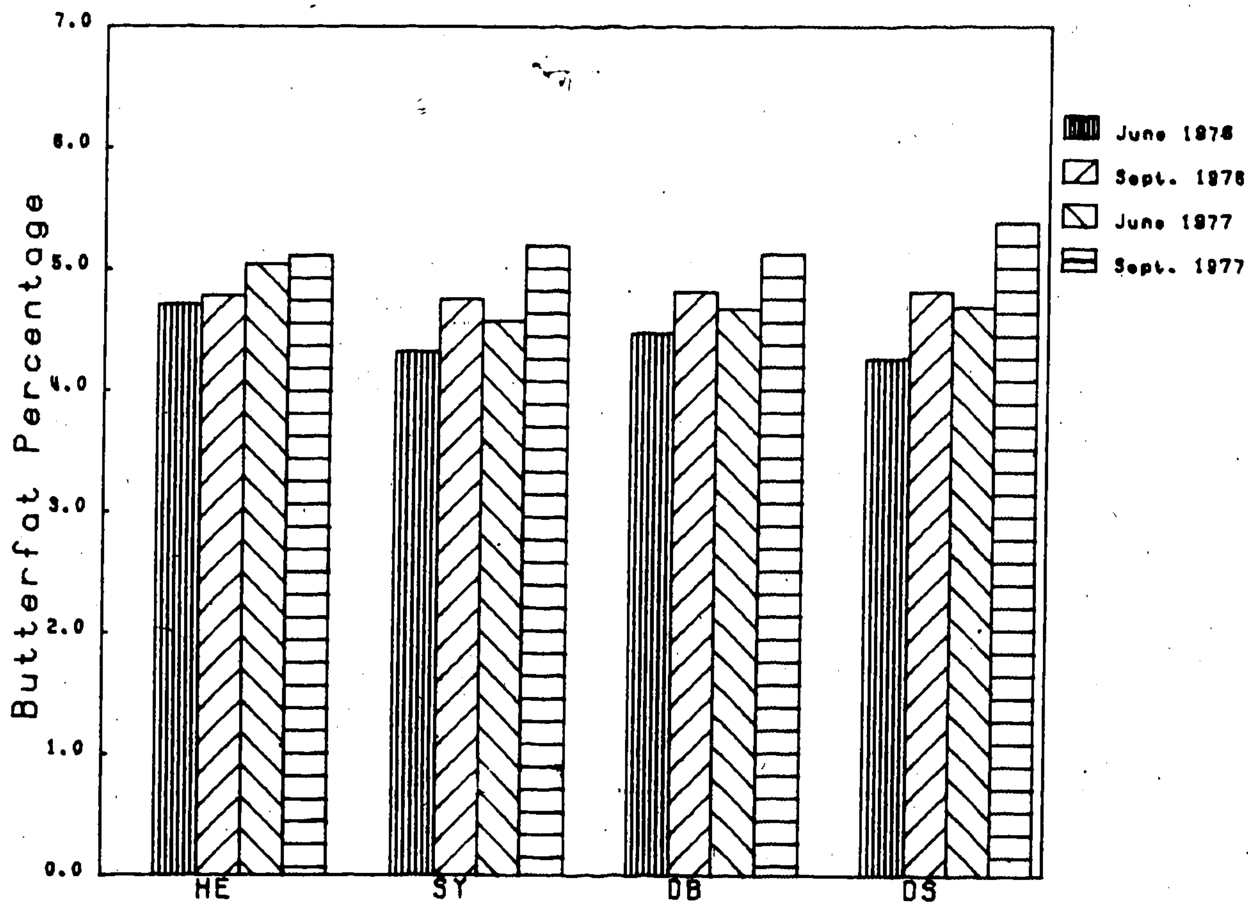
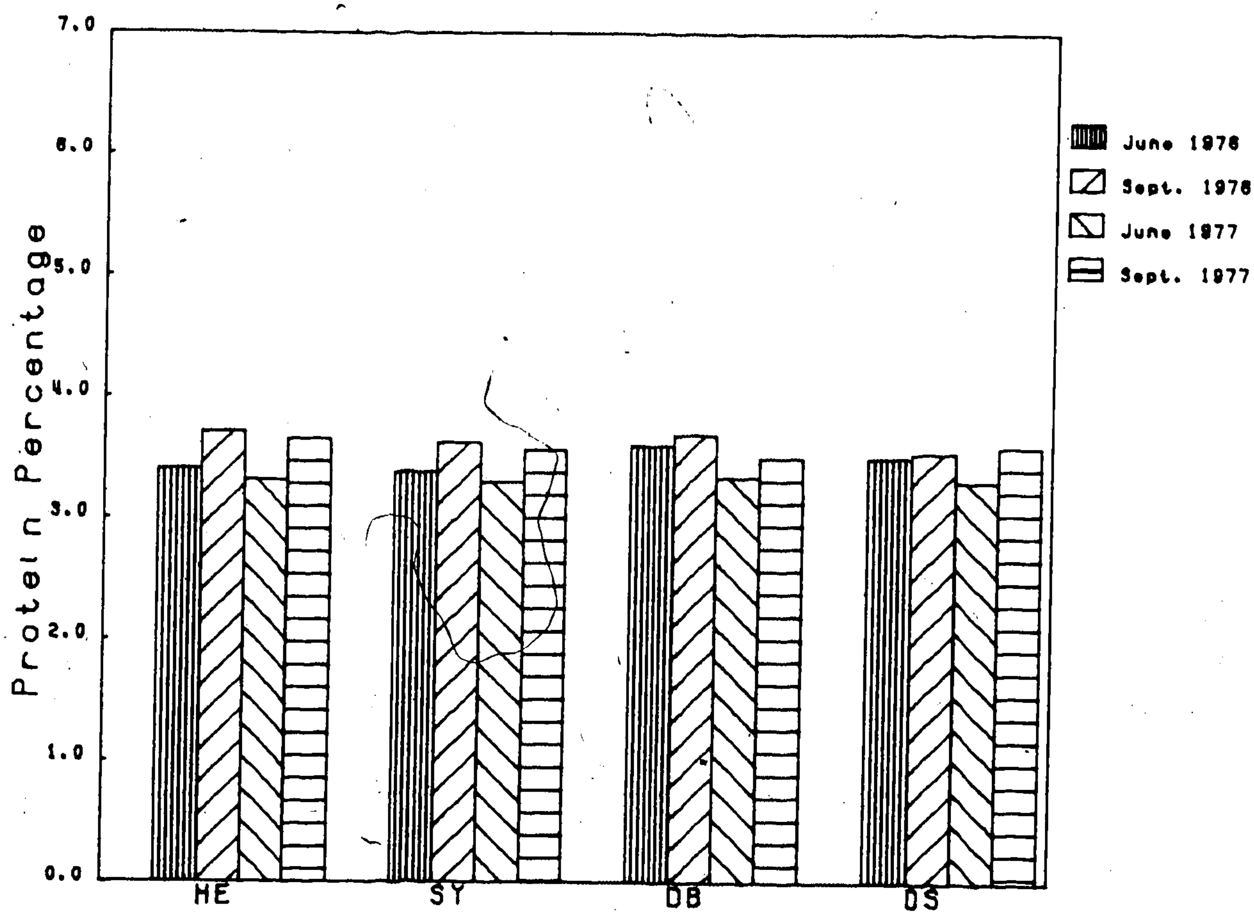
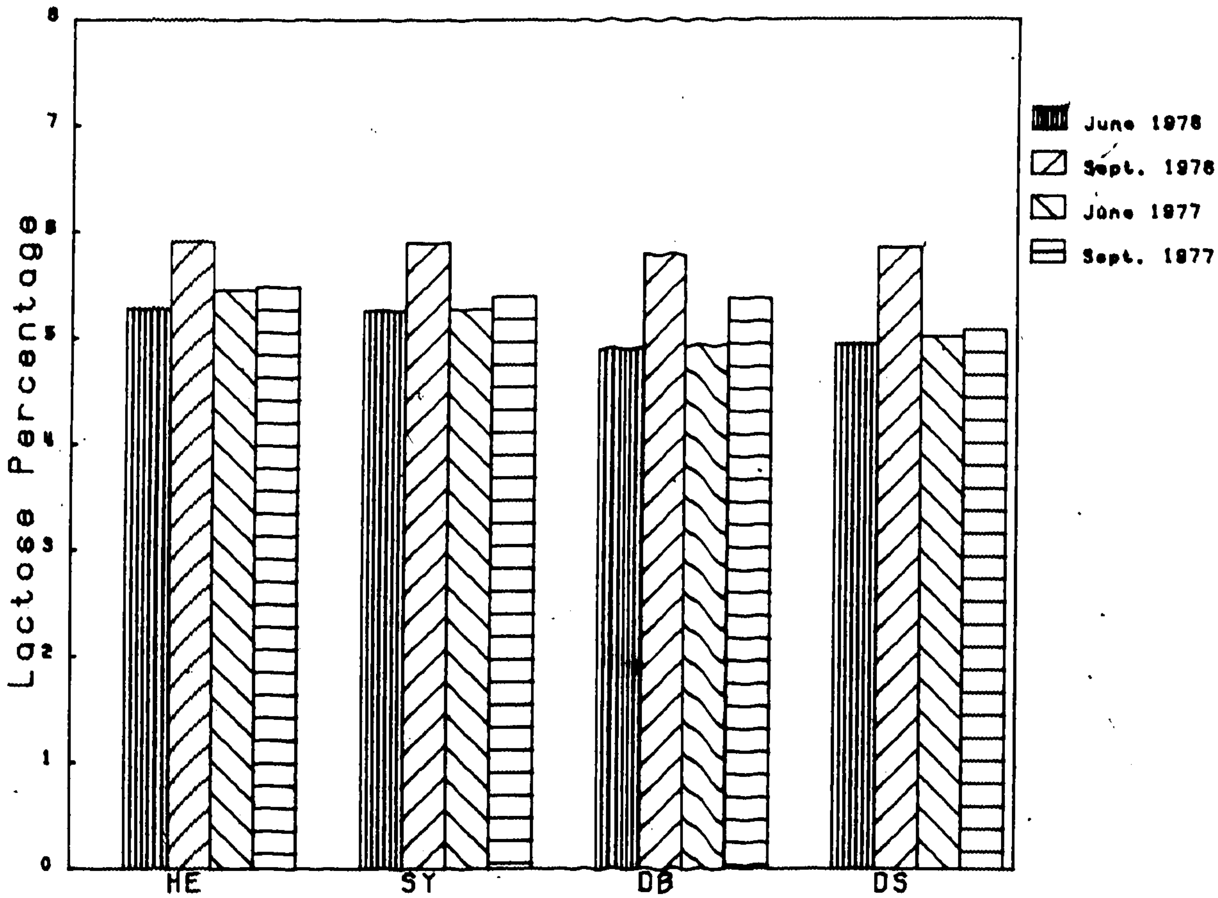
APPENDICES



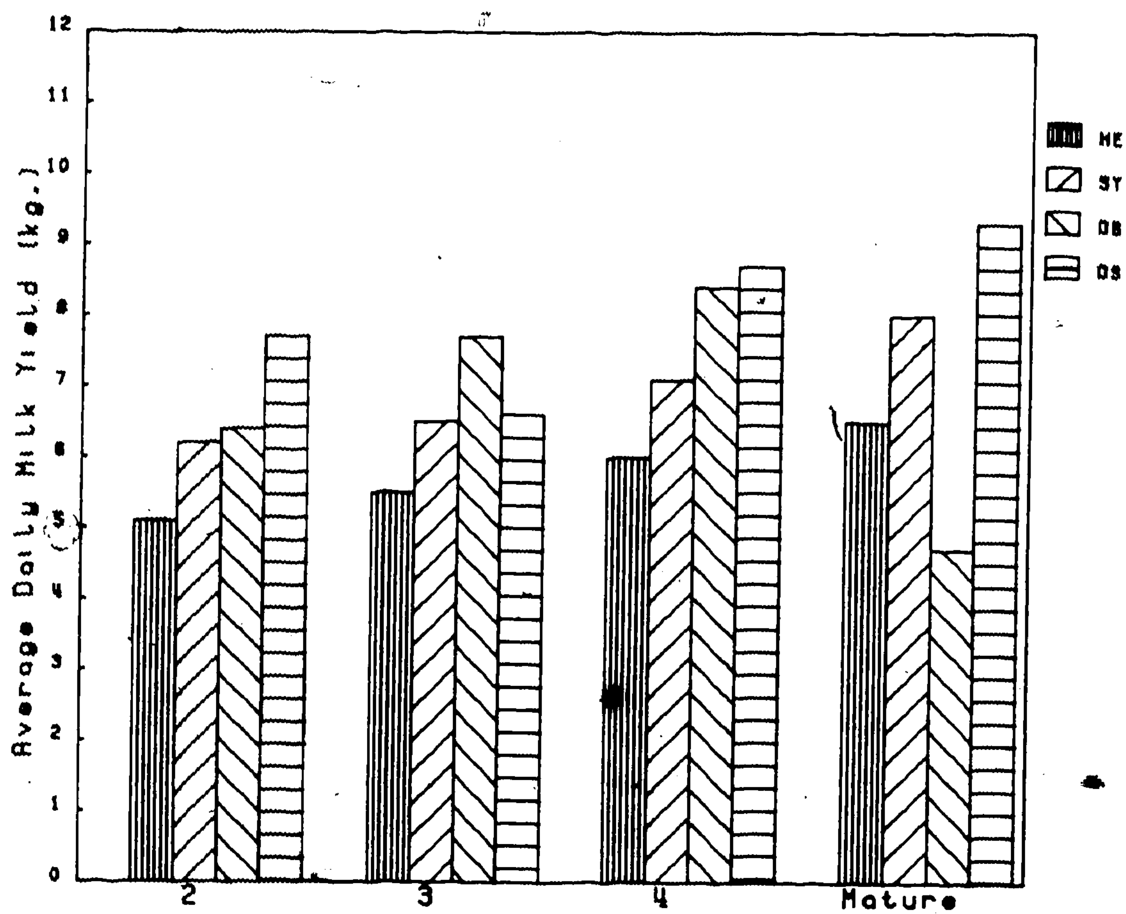
Appendix 1. June and September butterfat percent averages by breed of dam, Kinsella 1976-1977



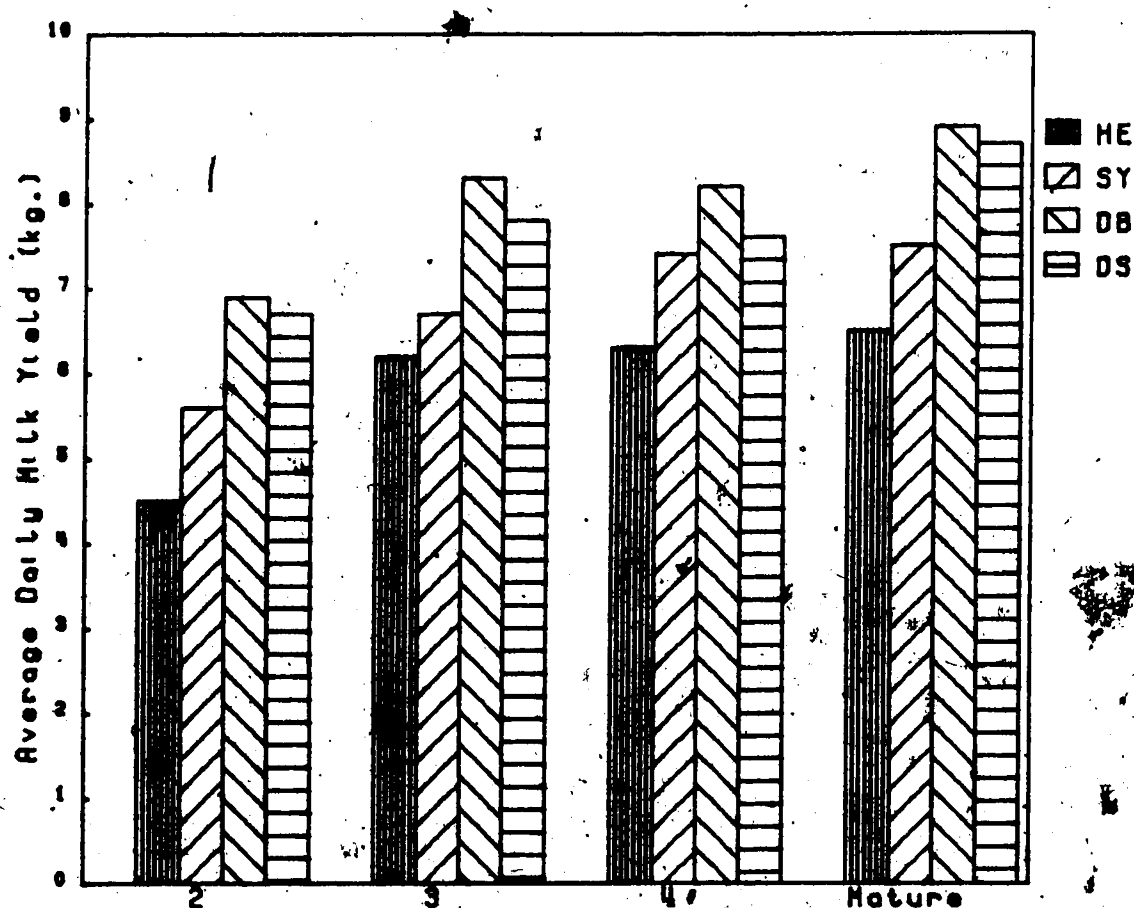
Appendix 2. June and September protein percent averages by breed of dam, Kinsella 1976-1977



Appendix 3. June and September lactose percent averages by breed of dam, Kinsella 1976-1977



Appendix 4. Average milk yield by breed and age of dam, Kinsella 1976



Appendix 5. Average milk yield by breed and age of dam, Kinsella 1977

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