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Sire-of-fetus effects on performance of the dam's current calf in beef cattle

David Shannon

To the Graduate Council:

I am submitting herewith a dissertation written by David Shannon entitled "Sire-of-fetus effects on performance of the dam's current calf in beef cattle." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Animal Science.

Robert R. Shrode, Major Professor

We have read this dissertation and recommend its acceptance:

Leonard M. Josephon, R.L. Murphree, Don O. Richardson, John D. Smalling

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Accepted for the Council:

L Evans Roth

Vice Chancellor
Graduate Studies and Research

SIRE-OF-FETUS EFFECTS ON PERFORMANCE OF THE DAM'S CURRENT CALF IN BEEF CATTLE

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

David Shannon

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ABSTRACT

Data recorded from a total of 5,618 calves from the herds at the Plateau Experiment Station (PES) and Tobacco Experiment Station (TES) of the University of Tennessee were available for analysis. Weight and condition score were recorded for these calves three times during their first year of life. Standard adjustment, including those to remove variation due to differences in age and sex of calf and age of dam, were made for each of these variables. In addition for the present purpose, the data were adjusted to remove variation due to differences between sires of calves.

Analysis of the adjusted data revealed that there was a significant effect of sire of fetus carried by the cow upon the performance of her currently nursed calf with respect to both variables at all three collection times in the TES data. The PES data followed a similar pattern; however, the effect on average daily gain at weaning and at a year of age was not significant.

Another analysis was performed on the same data to determine if the sex of the fetus had a similar effect; however, no such effect was revealed. Of the 6 combinations of variable and collection time at each of the two stations, sex of fetus was a significant effect in three at TES and in one at PES after adjustment to remove variation due to differences in birth weight of fetus.

In order to relate the age of the fetus to the magnitude of these effects on performance, a regression analysis of variance was performed using age of fetus as the continuous independent variable in the preweaning and weaning data. It was determined that, in the four combinations of variable and collection time, there was a signficiant regression on fetus age in the TES data, but in the PES data regression of condition score at preweaning and average daily gain at weaning on fetus age were not significant. The same analyses also revealed that these effects generally increased as age of fetus increased.

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CHAPTER I

INTRODUCTION

It has been known for several years that nature imposes upon calves factors which have great influence upon their growth. It has been observed also that some of these effects have their greatest impact while the calves are still young and nursing.

Sex and age have been shown to influence rate of development of calves. Examples, such as these, are cases in which the calf, itself, is directly affecting its own growth. In beef cattle, it has also been shown that the dam affects the growth of her calves in ways by which the sire has no influence. In addition, it has been determined that the magnitude of this effect changes as the cow matures. These three factors, age and sex of calf and age of dam, have been examined in great detail, and methods of adjustment have been developed to reduce their influence on estimates of individaul genetic merit.

While these three factors are normally adjusted from beef cattle data, many other factors are eliminated from similar estimates of genetic merit in dairy cattle breeding. The dairy breders have examined many factors in their attempts to obtain reliable estimates of individual genetic merit.

One of the areas that has received attention in the recent past is the possible effect of the sire of the fetus developing in the dam's uterus upon the subsequent lactation. The purpose of this study was to investigate a similar phenomenon in beef cattle in an effort to determine if there is an effect of the developing fetus upon the dam's current lactation as measured indirectly by performance of her concurrently nursing calf.

CHAPTER II

REVIEW OF LITERATURE

In 1975 a series of articles appeared in the literature reporting the results of investigations into the effect of the sire of the fetus upon a cow's lactation. These experiments, quite naturally, used dairy cattle as the experimental subject. Pioneers in this area were H. Skjervold and E. Fimland from the University of Norway.

Their studies (1975 a,b,c) included only first-calf dairy heifers calving in the fall of the years from 1971 thru 1974. Their analysis used both deviation from hard lactation average and maximum daily yield as dependent variables. They used a nested analysis of variance to estimate the components of variance. They obtained the components of variance attributed to the sire of the calves by nesting the sires of the cows within the sires of the calves. They also did the analysis nesting the opposite way, nesting sires of calves within the sires of cows. They had a large data set containing 48,852 lactations and 1,247 fetus sires. They reported correlations of from .08 to .13 between sire of fetus and lactation yield and from .07 to .09 between sire of fetus and maximum daily yield. All correlations, though small, were significantly different from zero.

They investigated also the effect of sex of calf (fetus) upon lactation and found none. They found no connection between breeding value of bull and the ability of the fetus to influence the lactation. This effect of fetus was shown to have a low heritability but large total genetic variation. They concluded that producers of nursing livestock have unwittingly been selecting for these fetal effects.

Adkinson, Wilcox, and Thatcher (1977) used 945,649 DHIA records from Florida, Georgia, North Carolina, and South Carolina during the eight-year period 1968 to 1975. They screened the data to be analyzed so that they included only Jersey cows mated to Jersey bulls and only Holstein cows mated to Holstein bulls. Only twice-a-day milking records were used. In addition, the length of the milk record had to be greater than 29 days and the days open greater than 39 days. In addition to these requirements, identification requirements had to be met, and all yield variables had to have non-zero values.

After this screening these researchers had a data set composed of 30,931 records which they studied to determine whether the sire of the fetus that indicated the lactation somehow influenced that same lactation. Harvey's LSML mixed model programs and GLM procedure of SAS·76 were used to analyze the data. In addition, they used the MATRIX procedure of SAS·76 to estimate components.

Sire of fetus accounted for 11.8% (Jersey data) and %8.2 (Holstein data) of the variability in milk yield. This effect was even more pronounced in predicting fat yield, accounting for 14.3 and 9.8% of the variation. In the Holstein data the magnitude of the sire-of-fetus effect was about half the size of the sire-of-the-cow effect. In the Jersey data it was almost equal to the effect of the dam's sire in importance.

Similar results were reported by Quesnel et al. (1979). They analyzed 3,776 records from the Florida Agric. Exper. Station dairy herd. Their data were composed of 702 Holstein and 1047 Jersey records. They found that differences in sire of fetus accounted for 1.4 and 7.3% of the variation in fat yield in the two breeds, respectively.

Sharma et al. (1979) reported results of a like nature. They used 27,200 Holstein and 3,731 Jersey DHIA records and found that sire-of-fetus effects accounted for 4.5 and 8.3% of the milk yield variation and 4.9 and 12.2% of the fat yield variation in the two breeds, respectively.

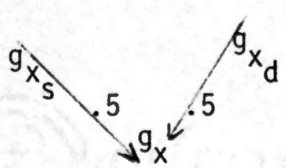
Smaller estimates of the importance of fetal sire effects were found by Johnson and Van Vleck (1979). First lactation records of 7,000 cattle from DHIA data indicated that the sire-of-fetus effect was less than 1% of the within-herd-year-season variance. They conlcuded that the effects of fetal sire are negligible.

Correlation analyses were performed by a number of the researchers. For the four years they studied, Skjervold and Fimland (1975 a,b,c) calculated an average of .0825 for the correlation of genotype of sire-of-fetus with first lactation yield.

Johnson and Van Vleck (1979) calculated a simple correlation of .10 between estimated fetal effect and the most recent proof. The genetic correlation was reported to be about .25.

Adkinson et al. (1977) calculated phenotypic correlations of .96 between sire of fetus and yield in both Holsteins and Jerseys. They calculated also a correlation between -.04 between sire-of-fetus and Predicted Difference (P D) of bulls.

A traditional explanation of the genetic make-up of an animal would be



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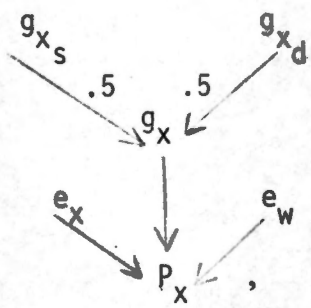
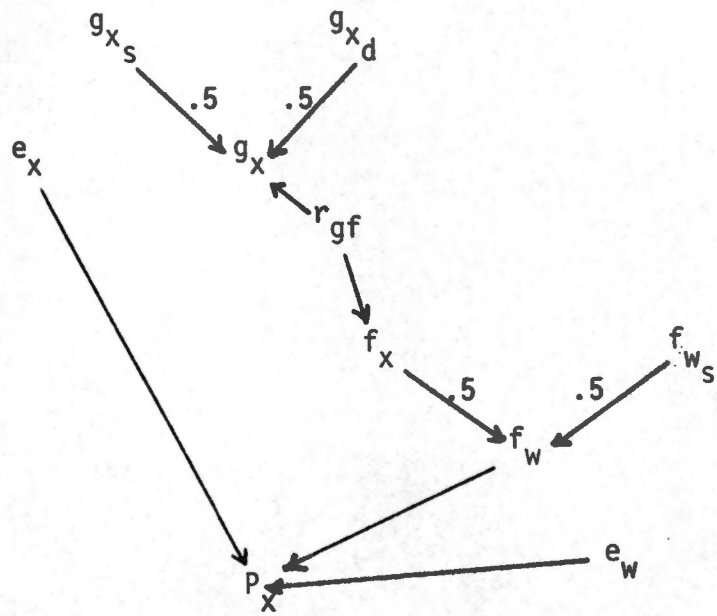
where the g's indicate genotypes, the s indicates the sire, the d indicates the dam, and the x's refer to an animal x. This diagram presents in its simplicity the foundation of animal breeding. A diagram of this nature which would represent the effects of inheritance and environment on the milk production of a dairy cow could be drawn



where the additional elements indicate the mating of a bull (w) to cow (x) resulting in the lactation (P) which is influenced by the environment (e). Both genotype and environment enter into such a diagram. Environmental effects, such as nutrition, which directly influence the lactation through the cow herself are symbolized by e_x. Although the input of the bull is genetic in terms of producing a calf, the effects (e_w) are environmental to the lactation of the cow. A mathematical model of such a figure would be $P = G + E$. In this model the lactation would be P, the genetic ability of the cow would be G, and environmental influences would be E.

Both Van Vleck (1978 a) and Skjervold and Fimland (1975 c) presented such diagrams of the means by which the sire of the fetus influences the lactation of his mate. A composite of their drawings using the notation of Van Vleck would be



where the additional elements indicate environment influences (e_w and e_x), the fetal effects (f_x,f_w, and f_{w_s}), and the genetic relationship of the fetus to the dam (r_{gf}). In this drawing f_w is the fetal genetic effect and is presumably the agent thru which the sire of the fetus, f_{ws}, acts. It is the last effect, f_{w_s}, that the investigators presented earlier have studied.

A model of the more elaborate figure above would have to account for the genetically determined influence of the fetus. As presented earlier, this effect is genetic, but it is not a direct genetic effect and would be an environmental effect on the cow. A model showing the random effects was presented by Van Vleck (1978 a) for estimating the variances of direct and fetal sire effects and for predicting sire values. His model followed the form

$$P_{ijk} = s_i + t_j + (st)_{ij} + r_{ijk}$$

,where P_{ijk} is the record of the female, s_i is the effect of the sire of the female, and t_j is the effect of the sire of the fetus which is one-half the fetal additive genetic value of the sire of the fetus, j.

Van Vleck (1978 b) developed a procedure to estimate the relative economic values of effects of sire of cow and sire of fetus. He found that for 10 years invested in selecting a new sire and a 10% discount rate the relative economic weights for direct and fetal effects would be 1.240 and 1.284, while if the fetal sire effects persisted in later lactations the economic weight for them would increase to 3.184.

Van Vleck (1978 c) investigated the expected milk-production responses to the direct effects and fetal effects. He found that to assume no economic importance of fetal effects when such effects exist could lead to reduced economic return when selecting replacements. He concluded that "good" estimates of genetic covariances and variances of direct and fetal effects need to be established in order to determine the real importance of fetal effects.

At the present time the exact mechanism by which fetus influences the lactation initiated by the birth of the fetus or the lactation in progress while the fetus is carried is not known. However, several of the researchers have proposed possible explanations for the occurrence of this phenomenon. Skjervold and Fimland (1975 c) citing Tucker (1969) wrote that fetal placental hormones had an increasing importance in stimulating mammary development and, by the middle of gestation, they might be the limiting factor in mammary development. They suggested that there might be heritable differences in the sires' abilities to produce fetuses that were capable of exerting this hormonal control. Adkinson, Wilcox, and Thatcher (1977) suggested that this hormonal control might be due to estrogens since their concentration is higher in the uterine vein than in peripheral blood. Furthermore, Smith et al. (1973) showed that estrogen concentration increases during the last 2 or 3 weeks of pregnancy. Adkinson et al. (1977) also cited research by Osinga (1970), which indicated that heritability of urinary excretion of estrone and estradiol 17a at 260 days of gestation were .28 and .38, respectively.

Another hormone possibly implicated is bovine placental lactogen (bPL) which has been shown to be secreted for at least 100 days prepartum. It is suggested that placental lactogens are necessary for mammary gland development (Bolander et al., 1976). The prepartum level of bPL is apparently directly related to subsequent lactation. Also, it has been shown that dairy cattle have higher levels of bPL than beef cattle.

Almost all of the research in this area has, quite naturally, involved the use of dairy cattle. This is still a new area with ongoing research. The degree to which the fetus affects the lactation and the genetic and economic implications of this affect have yet to be clearly defined.

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CHAPTER III

EXPERIMENTAL PROCEDURE

The data used in this study are from experimental cattle of the herds at the Plateau Experiment Station and Tobacco Experiment Station of the University of Tennessee. At the time of this experiment each station had only one breed of cattle represented. The Plateau Experiment Station (PES) at Crossville produced only Angus cattle, while the Tobacco Experiment Station (TES) at Greeneville produced only Polled Hereford cattle, making for complete confounding of station and breed. These cattle are the experimental material in Tennessee's contribution to Project S-10, the Southern Regional Beef Cattle Breeding Project. The data studied here were collected from calves born in 1967 through 1978. The numbers of calves in the study by the year, breed, and sex are shown in Table 1.

As a result of a limited breeding season, the calves were born in January, February, and March. Approximately July 1 of each year, the cows were segregated according to the sex of the calf they were nursing. The calves were not creep fed. When weaning, the calves were placed in dry lots according to sex and size. At this time the feeding regime of the heifer and bull calves were changed.

The heifer calves were fed daily a ration of corn silage *ad libitum*, two pounds of hay, two pounds of grain, and one-half pound of protein supplement each. This ration was designed to produce an average daily gain of about one pound per day which would consist of a limited amount of fat. The bull calves were fed a more liberal ration. They

TABLE 1

NUMBER OF CALVES BY YEAR, BREED, AND SEX

	NUMBER OF CALVES						
Year	Bulls	Heifers	Total	Bulls	Heifers	Total	Grand Total
1967	17	22	39	79	73	153	191
1968	27	27	54	79	90	169	223
1969	20	18	38	70	69	139	177
1970	31	29	60	72	76	148	208
1971	44	32	76	88	71	159	235
1972	42	44	86	77	84	161	247
1973	50	45	95	94	78	172	267
1974	46	60	106	101	84	185	291
1975	45	56	101	96	99	195	296
1976	43	39	82	85	96	181	263
1977	51	47	98	54	44	98	196
1978	41	47	88	77	55	132	220
Totals	457	466	923	972	919	1891	2814

were fed daily corn silage ad libitum with about two pounds of hay and about one pound of a 14% protein grain mixture per cwt of live weight. These rations were fed until the first of April, at which time the yearling replacement heifers were placed upon pasture and no more supplemental feeding was provided until the next winter.

Three lines of cattle were maintained at PES, while only two were maintained at TES. Control and select lines were maintained at both stations. An additional inbred line also was maintained at PES. In addition to these five lines of cattle, any additional group of cattle which was composed of cattle from the same Angus foundation stock but not actually in the regional project was represented in the PES data.

Within each of the lines, except the inbred line, matings were planned to minimize the inbreeding. The inbred line matings were made by a system which avoided very high inbreedings.

Each of the 5 lines was composed of approximately 60 brood cows. Each line was divided into 4 smaller groups of 15 cows each for pasture breeding to a selected yearling bull. As a result of using yearling bulls and culling cows at seven years of age, regardless of their productivity, the generation interval was reduced from over 5 years in 1968 to slightly more than 3 years in 1978.

A total of 5,618 records were available for this analysis. As restrictions were imposed upon the data, the number of records were, of course, reduced. These restrictions included requiring the brood cow to have at least two consecutive years of production in the herd. The only other restriction which was initially imposed was that the sire of each calf had to be known. Missing data also caused observations on some animals to be removed.

Records from three weighing times were available for analysis. These times correspond to about 120 days of age (often referred to as "preweaning"), to the time of weaning at about 230 days of age, and to the average first birthday of the calves.

Two dependent variables were used in the analysis. These variables were average daily gain (ADG) and condition score (COND). These variables were recorded at each of the three data collection times previously described. For the sake of brevity elsewhere in this discussion, these variable-time combinations shall be referred to through the use of acronyms just presented followed by a number which refers to the time of collection. For example, average daily gain up to preweaning would be ADG1.

In all cases the weights from which the ADGs were calculated were recorded to the nearest five pounds. After calculation of the ADGs but prior to the actual statistical analysis each of the three variables was adjusted by least-squares procedures to remove variation due to differences in age and sex of calf and age of dam. The effects of the nursing calf's sire were also removed at this same time.

COND is a subjective numerical rating of fatness as visually determined and corresponds approximately to slaughter grade, with a minimum of 1 and a maximum of 16. The averages of the variables after adjustment are presented in Table 2.

It should be mentioned at this point also that the gains are incremental gains. That is, ADG2, is not the gain from birth to weaning but is the average daily gain from the end of the preweaning period to the day of weaning. COND is the subjective value as determined on the

TABLE 2

MEANS OF VARIABLES INCLUDED IN THIS STUDY. TEST AND PES DATA.

Variable	TES N	TES Mean ± Std. Error	PES N	PES Mean ± Std. Error
ADG1	984	1.57 ± .01	2033	1.80 ± .01
COND1	985	8.44 ± .05	2057	9.10 ± .02
ADG2	691	1.64 ± .02	1490	1.83 ± .01
COND2	796	8.46 ± .05	1579	9.17 ± .02
ADG3	572	1.32 ± .01	1276	1.19 ± .01
COND3	521	8.95 ± .05	1224	9.07 ± .03

same day weights were recorded. Thus, COND would refer to the condition score recorded at the postweaning data collection.

All of the statistical analysis presented here were performed through the use of procedures available in the SAS·76 software package. The adjustments were performed with the aid of the GLM procedure. An output data net was constructed using this procedure. It was this adjusted data set that was actually analyzed. The analyses of variance were also performed by use of the GLM procedure. The means and correlations were calculated by the CORR procedure.

CHAPTER IV

RESULTS AND DISCUSSION

The studies cited in Chapter II differ in two quite distinct ways from that presented here. First, without exception, the previous sire-of-fetus studies were based on lactation yield in dairy cattle. This study used beef cattle as the subject animal. Second, in the preceding experiments, the sire-of-fetus effect was defined as the fetal influence upon the lactation exerted before the cow freshened. That is to say, the sire and fetus to which the effects were being attributed were the same ones that initiated the lactation. In this study, the sire-of-fetus effect investigated is that of the fetus the cow is carrying during the lactation in question. Additionally, the effect is measured not on the cow's lactation directly but indirectly on the basis of growth of the calf that the cow is nursing. Therefore, the purpose of the present study was to determine the effect, if any, that the sire of the fetus a cow is carrying has upon the calf she is currently nursing.

Table 3 and 4 show the analysis of variance of the traits studied with sire-of-fetus as the independent variable. This effect was highly significant ($P<.01$) on all traits at TES. At PES this effect was significant at the same level on all variables except ADG3. In each table two data sets are represented. The first is a data set that was

TABLE 3

ANALYSIS OF VARIANCE OF ADJUSTED TRAITS OF NURSING CALVES USING SIRE OF FETUS AS THE INDEPENDENT VARIABLE. TES DATA.

Dependent Variable	Standard Adjustments			Standard Adjustments w/birth Week Added	
	Effect	df	MS	df	Ms
ADG1	SIREF	45	.3284	44	.2791**
	ERROR	488	.0214	447	.0220
COND1	SIREF	45	.0379**	44	3.2979**
	ERROR				
ADG2	SIREF			69	1.1068**
	ERROR			621	.1124
COND2	SIREF	82	.0057**	81	.6203**
	ERROR	943	.0017	870	.1823
ADG3	SIREF	60	.1356**	60	.1355**
	ERROR	511	.0886	511	.0886
COND3	SIREF	60	.0092**	60	.9195**
	ERROR	511	.0010	511	.1140

*.01 < P ≤ .05

**P ≤ .01

TABLE 4

ANALYSIS OF VARIANCE OF ADJUSTED TRAITS OF NURSING CALVES USING SIRE OF FETUS AS THE INDEPENDENT VARIABLE. PES DATA.

Dependent Variable	Effect	Standard Adjustments		Standard Adjustments with Birthwt. added	
		df	Ms	df	Ms
ADG1	SIREF	110	.0210**	108	.0202**
	ERROR				
COND1	SIREF	110	.0196**	108	1.6844**
	ERROR				
ADG2	SIREF	154	.1049**	139	.0187**
	ERROR				
COND2	SIREF	164	.0241**	161	2.3196*
	ERROR	2183			
ADG3	SIREF	130	.0511	130	.0371
	ERROR	1145	.0570	1145	.0570
COND3	SIREF	130	.0098**	130	.9849**
	ERROR	1145	.0002	1145	.0242

*$.01 < P \leq .05$

**$P \leq .01$

adjusted to remove the effects of sex and age of calf, age of dam, and sire of nursing calf. The second data set was adjusted for these effects plus adjustments to remove the effect of eventual birth weight of the fetus.

These tables point out that the developing fetus exerts an effect upon the current lactation of the cow as indicated by the gain and condition score of the calf the cow is nursing. Though, as indicated in the literature review, fetal effects probably are most apparent later in the lactation, the results shown here indicate that fetal effects are statistically significant by the preweaning data collection time. At the preweaning collection at TES, the average age of fetus was 50.6 days and the average age of nursing calf was 139.1 days. At PES, the average fetus age was 56.2 days, and the nursing calves averaged 143.9 days of age. Therefore, the expression of these effects appears to begin shortly after implantation of the embryo has occurred.

At the weaning collection at TES, the average age of fetus was 141.9 days, and the nursing calves averaged 227.2 days of age. At PES, the average fetus age was 140.2 days, and that of nursing calf was 229.4 days. In calculating these means of the fetus' age, values of zero, which, of course, indicate that conception has not yet occurred, were not eliminated from the calculation.

The age of the fetus was not calculated for the postweaning collection since it would not be meaningful. Any direct effect of the fetus upon the characters measured would cease at weaning. In spite of this the effect on all the traits persisted to the postweaning collection at TES and on COND3 at PES.

In an effort to determine the relationship between fetus age and the dependent variables, regression analyses were performed. The results of the analyses are presented in Table 5 and Table 6. In the TES data, this regression with respect to all preweaning and weaning variables was at least significant ($P<.05$) and, in most cases, was highly significant ($P<.01$). Interestingly, though the regression of ADG2 on fetus age is highly significant, it is negative.

In the PES data, fetal age did not significantly affect COND1 or ADG2 but highly significantly affected the other variables. In these data, ADG1, ADG2, and COND2 exhibit negative regressions on fetus age. Since the effects of FAGE are not significant where ADG2 is concerned, it may be discounted. However, the negative regressions of ADG1 and COND2 on fetal age in the PES data and that of ADG2 on fetal age in the TES data defy explanation. However, the overall trend in the data is for age of fetus to have significant influences which increase as age of fetus increases.

Rank correlations between the eventual sire averages attained by the calves which were the fetuses of interest and the individual nursing calf characters are shown in Table 7 and Table 8. The averages by sire correspond to the time that the individual calf variables represent. That is the fetus correlated to ADG1 are those of preweaning traits, etc. The trend is for the progeny averages of sire and fetus to be positively associated with the corresponding individual suckling calf trait. This seems reasonable and implies that fetal effects reinforce the characters displayed by the nursing calf.

In the course of the research, the question as to the effect of the sex of fetus upon the nursing calf arose. To answer this

TABLE 5

ANALYSIS OF REGRESSION OF ADJUSTED TRAITS OF NURSING CALVES ON AGE OF FETUS. TES DATA.

	Effect	df	MS
ADGL	Regression	1	.1975*
	Error	456	.0441
COND1	Regression	1	6.6698**
	Error	456	.4355
ADG2	Regression	1	2.7650**
	Error	794	.2570
COND2	Regression	1	2.9455**
	Error	794	.1862

*$.01 < P \le .05$

**$P \le .01$

TABLE 6

ANALYSIS OF REGRESSION OF ADJUSTED TRAITS OF NURSING CALVES ON AGE OF FETUS. PES DATA.

	Effect	df	MS
ADG1	Regression	1	.1571**
	Error	896	.0129
COND1	Regression	1	.1517
	Error	896	.2176
ADG2	Regression	1	.1505
	Error	1577	.0702
COND2	Regression	1	95.1109**
	Error	1577	.3017

*.01 < P ≤ .05

**P ≤ .01

TABLE 7

CORRELATIONS BETWEEN INDIVIDUAL NURSING CALF TRAITS AND AVERAGE OF PROGENY OF SIRE OF FETUS. TES DATA.

	FETAL SIZE AVERAGES	
	ADGF	CONDF
ADG1	.18**	.07
COND1	.12**	.07
ADG2	.27**	.31**
CCND2	-.07*	-.08**
ADG3	-.03	.02
COND3	.05	.30**

*.01 < P ≤ .05

**P ≤ .01

TABLE 8

RANK CORRELATIONS BETWEEN INDIVIDUAL NURSING CALF TRAITS AND AVERAGE OF PROGENY OF SIRE OF FETUS. PES DATA.

	Fetal Sire Averages	
	ADGF	CONDF
ADG1	.10*	.13**
COND1	-.12**	.19**
ADG2	-.01	0
COND2	-.24*	.34**
ADG3	.01	.04
COND3	-.12**	.29**

*.01 < P ≤ .05

**P ≤ .01

question additional analyses were performed. The results of these analyses are shown in Tables 9 and 10. It is interesting to note that, for the most part, sex of fetus does not affect the characters studied. This is particularly true at TES. When the effects of the fetus' eventual birth weight also were adjusted out, COND1, COND2, and COND3 were all significantly affected by sex. In the PES data, when effects of birth weight of fetus were removed, ADG1 also was significantly affected.

These results seem to indicate that there is an effect of a developing fetus upon the performance of a nursing calf. This effect seems to increase as the fetus ages. The sex of the fetus does not appear to be as important in affecting the characters studied as does the sire of the fetus. It appears that sires that produce desirable calves have positive effects upon the performance of suckling calves not sired by them.

In the data used in the present study, the existence of separate lines in each of the herds makes for confounding of sire and line. The lines have been completely separate for less than three generations and have not diverged to any measurable extent. However, further analysis should be conducted to test the significance of sire-of-fetus effect on a within-line basis. If the confounding of sire and line has been responsible for any bias in the analyses, as conducted here, without using line as a classification criterion, analyses on a within-line basis should be free of any such bias.

It is common in the beef industry for the producers to provide the best brood cows with the best mates. This was not the case in these data as cows were allocated at random among the service sires within group. In a like manner groups were allocated at random to pasture.

TABLE 9

ANALYSIS OF VARIANCE OF ADJUSTED TRAITS OF NURSING CALVES USING SIRE OF FETUS AS THE INDEPENDENT VARIABLE. PES DATA.

Dependent Variable	Effect	Standard Adjustments		Standard Adjustments w/ Birth Wt. Added	
		df	Ms	df	Ms
ADG1	SEX F	1	.0665	1	.1496
	ERROR	492	.0477	491	.0456
COND1	SEX F	1	1.5029	1	2.7830*
	ERROR	492	.4864	491	.4732
ADG2	SEX F	2	.2714	1	.0643
	ERROR	905	.2737	679	.2102
COND2	SEX F	2	.3508	2	1.7780**
	ERROR	957	.2051	954	.2162
ADG3	SEX F	1	.0206	1	.0206
	ERROR	569	.1790	569	.1790
COND3	SEX F	1	.2733	1	1.4413**
	ERROR	570	.1830	570	.1965

*$.01 < P \leq .05$

**$P \leq .01$

TABLE 10

ANALYSIS OF VARIANCE OF ADJUSTED TRAITS OF NURSING CALVES USING SEX OF FETUS AS THE INDEPENDENT VARIABLE. PES DATA.

Dependent Variable	Effect	Standard Adjustments		Standard Adjustments w/ Birth Wt. Added	
		df	MS	df	MS
ADG1	SEX F	1	.0236	1	.2103*
	ERROR	1161	.0108	1161	.0113
COND1	SEX F	1	.0006	1	.1526
	ERROR	1161	.2228	1161	.2138
ADG2	SEX F	2	.0809	2	.1527
	ERROR	1823	.0709	1433	.0730
COND2	SEX F	2	.9488	2	.9196
	ERROR	2127	.3363	2124	.3342
ADG3	SEX F	1	.0273	1	.0273
	ERROR	1276	.1749	1276	.1749
COND3	SEX F	1	.1338	1	.1554
	ERROR	1274	.1221	1274	.1222

*$.01 < P \leq .05$

**$P \leq .01$

Therefore, both of these effects can be eliminated from consideration as possible alternative explanations of the results reported here.

This is still a new field with much research still to be done. Research areas that seem to be indicated are:

1- What is the relationship of these fetal effects to those presented in previously published papers?
2- How large are these effects relative to the effects that were statistically removed?
3- What differences exist in dairy and beef sires in their ability to affect lactation through this fetal effect?
4- What differences exist between dairy and beef cows in their ability to respond to these effects?
5- Does the confounding of sire and line in the present data as here analyzed cause any bias?

Although these effects may be, for the most part, only of academic interest at present, practical considerations might become important after further research in the area. For example, if these effects persist, just what practices will the beef or dairy producer follow in mating young cows and replacement heifers? Would it be economically desirable for them to mate these cows to bulls that had positive effects through fetuses sired by them so that later lactations, and later calves in the beef industry, would be larger. If such a practice appeared warranted, far reaching effects upon sire selection would result since these young cows form a large part of the population used to select sires.

Though these effects may receive additional study it is doubtful that the influence of sires of fetuses could be used in much of the beef industry for quite some time. Since mating of untested bulls is very common in the extensive beef production enterprises, little information about fetal effects could be put to use. Much of the beef industry is still characterized by extensive production operations rather than more intensive production which prevails with other species and classes of livestock. Until economic, political, and esthetic considerations change to support widely such practices as use of tested bulls with known breeding dates and the keeping of accurate records, the use of fetal effects in most of the beef industry is impractical and, in fact, impossible.

However, in what may be termed the "elite" segment of the industry, it would be possible to utilize information concerning fetal effects if these effects are demonstrated to be consistently important and measurable. These effects could be taken into account in estimation of bulls' breeding values on the basis of progeny averages and planning of matings to take advantage of favorable fetal effects to improve the performacne of calves nursed by cows whose lactations are influenced favorably by fetal effects.

CHAPTER V

SUMMARY

Data recorded from a total of 5,618 calves from the herds at the Plateau Experiment Station (PES) and Tobacco Experiment Station (TES) of the University of Tennessee were available for analysis. Weight and condition score were recorded for these calves three times during their first year of life. Standard adjustment, including those to remove variation due to difference in age and sex of calf and age of dam, were made for each of these variables. In addition for the present purpose, the data were adjusted to remove variation due to differences between sires of calves.

Analysis of the adjusted data revealed that there was a significant effect of sire of fetus carried by the cow upon performance of her currently nursed calf with respect to both variables at all three collection times in the TES data. The PES data followed a similar pattern; however, the effect on the average daily gain at weaning and at a year of age was not significant.

Another analysis was performed on the same data to determine if the sex of the fetus had a similar effect; however, no such effect was revealed. Of the 6 combinations of variable and collection time at each of the two stations, sex of fetus was a significant effect in three at TES and one at PES after adjustment to remove variation due to differences in birth weight of fetus.

In order to relate the age of the fetus to the magnitude of these effects on performance, a regression analysis of variance was performed using age of fetus as the continuous independent variable in the pre-weaning and weaning data. It was determined that, in the four combinations of variable and collection time, there was a significant regression on fetus age in the TES data, but in the PES data regression of condition score at preweaning and average daily gain at weaning on fetus age were not significant. The same analyses also revealed that these effects generally increased as age of fetus increased.

LITERATURE CITED

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Adkinson, R.W., C.J. Wilcox, and W.W. Thatcher. 1977. Effects of sire of fetus upon subsequent production and days open of the dam. J. Dairy Sci. 60:1964.

Bolander, F.F. Jr., L.C. Ulberg, and R.E. Fellows. 1976. Circulating placental lactogen levels in dairy and beef cattle. Endocrinol. 99:1273.

Johnson, L.P. and L.D. Van Vleck. 1979. Estimation of the genetic correlation between direct and fetal effects on first lactations of daughters and mates of Holstein sires. J. Dairy Sci. suppl. 1, 62:107 abstr.

Osinga, A. 1970. Estrogen excretion by the pregnant bovine and its relation with some characters of gestation and parturition. Mededelingen Landbouwhogeschool, Wageningen, Nederland. 70:12.

Quesnel, F.N., D.E. Harmon, C.J. Wilcox, W.W. Thatcher, and A.K. Sharma. 1979. Sire of fetus effects upon milk production of the dam and several characteristics of the fetus. J. Dairy Sci., suppl. 1, 62:106 abstr.

Sharma, A.K., C.J. Wilcox, R.C. Littell, W.W. Thatcher, and R.W. Adkinson. 1979. MivqueO estimates of sire of fetus effects on milk yield and days open. J. Dairy Sci., suppl. 1, 62:106 abstr.

Skejervold, H. 1975. Har fosterets far noen innvirknins pa moras mjolkeavkastnins? (Does the sire of the fetus have some effect on the milk yield of the dam?) Nor. Landbruk. 16:10.

Skjervold, H., and E. Fimland. 1975a. Evidence for a possible influence of the fetus on the milk yield of the dam. Z. Tierz Zuchtungsbiol. 92:245.

Skjervold, H. and E. Fimland. 1975b. Har far til fosteret noen innvirknins pa moras mjolkeavkasting? (Does the sire of the calf have some influence on the dam's milk yield?) Landbrukstidende. 81:656.

Skjervold, H. and E. Fimland. 1975c. Har far fosteret noen invirkning pa moras mjolkeavkastning? (Does the sire of the calf have some influence on the dam's milk yield?) Meieriposten. 64:523.

Smith, V.G., L.A. Edgerton, H.D. Hafs, and E.M. Convey. 1973. Bovine serum estrogens, progestins and glucocorticoids during late pregnancy, parturition and early lactation. J. Anim. Sci. 36:391.

Tucker, H.A. 1966. Regulation of mammary nucleic acid content by various suckling intensities. Amer. J. Physiol. 210:1209.

Van Vleck, L.D. 1978a. A genetic model involving fetal effects on traits of the dam. Biometrics 34:123.

Van Vleck, L.D. 1978b. Economic weights for direct and fetal genetic effects in choosing sires. J. Dairy Sci. 61:970.

Van Vleck, L.D. 1978c. Expected responses to selection for direct and fetal genetic effects. J. Dairy Sci. supp 1, 61:680.

VITA

David Shannon was born July 22, 1950, in Nashville, Tennessee. He received his elementary education at Elm Grove Elementary School in Oak Ridge, Tennessee and at Karns Elementary School in Knoxville, Tennessee. In June 1968 David graduated from Karns High School and entered the University of Tennessee at Knoxville and received his Bachelors' degree in Animal Husbandry in June 1973. In September 1973 David entered the Graduate School of the University of Tennessee at Knoxville and obtained his Masters' degree in Animal Science in December 1975. Upon completion of that degree David began work on the Ph.D. degree which was completed in June 1980.