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The Effects of Breeding Maturity on Dystocia and Rebreeding of the Primiparous Beef Female

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Summary

Maturity Index (MI) was used in a Probit regression as an explanatory variable of dystocia, where dystocia was used in a Probit regression as an explanatory variable of rebreeding rates of primiparous cows from data collected on replacement heifers from the Gudmundsen Sandhills Laboratory. Dystocia was found to decrease from about 40% to 13% for heifers when the MI increased from 53 to 70, supporting the notion that maturity reduces the incidence of dystocia, resulting in an increase in the second pregnancy rate.

Introduction

The optimal size to breed the replacement female is a major concern of the cow-calf operator. An important consideration is the dystocia rate of the replacement female. Dystocia is a time-consuming and costly event. Producers have long included dystocia rates in their evaluation of bull genetics and relate this directly to their replacement heifer breeding regimes. Key to determining the optimal pre-breeding size of the replacement heifer is an understanding of the effects that size and maturity have on dystocia and, in turn, understanding dystocia's effect on second pregnancy.

The maturity index (MI) is used to predict breeding readiness of replacement beef females. For a complete explanation of how and why this index was developed, please refer to the article entitled "Moving Beyond Weight as the Only Predictor of Breeding Readiness: Using a Breeding Maturity Index" (pp. 19-21) in the current beef report.

Procedures

Data used to relate dystocia to MI and second pregnancy rates were taken from two experiments used to identify breeding readiness of several groups of beef heifers fed to four different pre-breeding weights at the Gudmundsen Sandhills Laboratory (GSL). The results from these studies were published in the *2002 and 2005 Beef Cattle Reports*, pp. 4-7 and pp. 3-6, respectively. These studies included 500 heifers, but only those heifers that calved (n = 448) were included in the analysis relating MI to dystocia, and only cows that were retained to the determination of their second pregnancy (n = 422) were included in the analysis of dystocia on pregnancy rates of primiparous cows.

Probit regression, a type of limited dependent variable regression technique, was used for both analyses. In the first analysis, the dependent variable was dystocia, limited to a value of one if the heifer required assistance at the time of parturition, or a zero if no intervention occurred. It was expected that MI would have an inverse relationship with dystocia. Three different functional relationships were compared: linear, quadratic and cubic forms. The models were evaluated using the Normalized Success Index (NSI) as described on page 294 of the *Shazam Econometrics Software User's Reference Manual*. Briefly, NSI is the proportion of predictions that were correct. The cubic form of the Probit was selected as the best model.

In the second analysis, the dependent variable was pregnancy of the primiparous animal and was assigned a value of one if the cow was diagnosed as pregnant and zero if otherwise.

Table 1. Normalized Success Index for three formulations of MI.

Form of MI	Normalized Success Index
Linear	0.034
Quadratic	0.086
Cubic	0.099

Table 2. Marginal changes in dystocia rates at selected MIs.

MI	Marginal Change of Dystocia
50	-3.74%
55	-2.69%
60	-1.57%
65	-0.71%
70	-0.06%

Results

Equation 1 shows the results of the cubic Probit estimation.

Equation 1

$$z = 6.185 - 0.104\ MI - 0.00145\ MI^2 + 0.0000207\ MI^3$$

Where:

z = Distance from zero in a normal distribution in terms of standard deviations and MI = Maturity Index

The coefficients were significantly different from zero, with all *P*-values less than or equal to 2%. The NSI results of all three equations are shown in Table 1. It should be noted that these results are only valid over the range of the data and that predictions outside of the data range might be nonsensical.

The probabilities of dystocia for all three models over the range of MIs of heifers in the study are illustrated in Figure 1. The linear and quadratic forms show that the probability of dystocia continues to decline as MI increases over the range of the data. The quadratic form of the model

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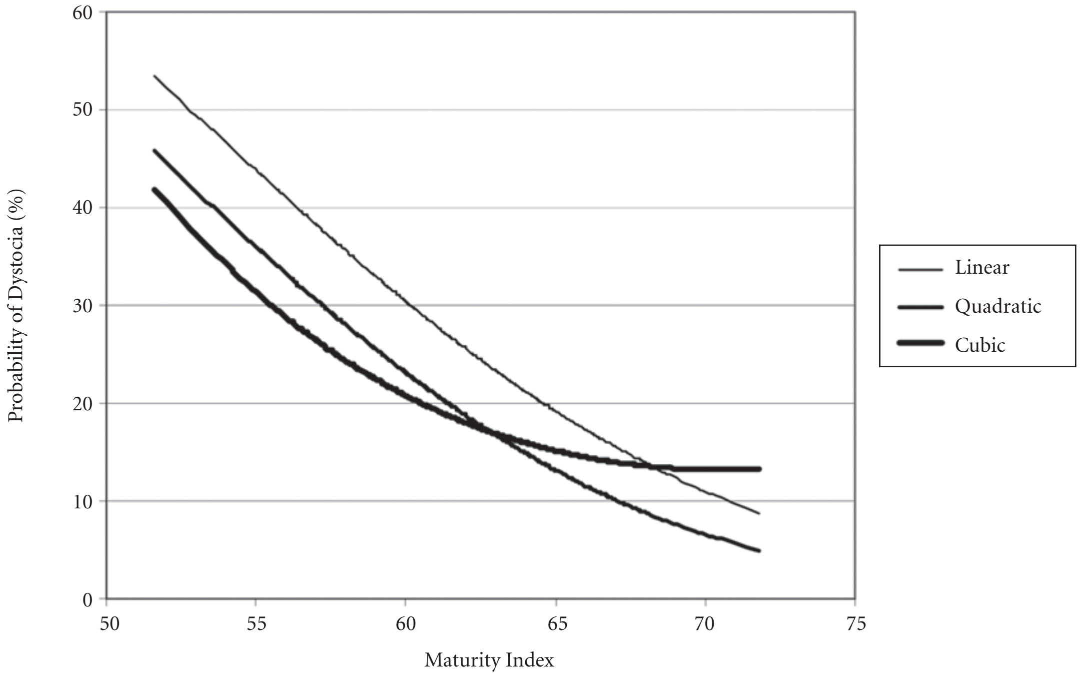

Figure 1. Dystocia rates as a function of Maturity Index as determined by a linear, quadratic and cubic probit.

reaches a minimum level of dystocia at a larger MI than does the cubic form. Results from the cubic regression show the probability of dystocia continues to decline until it reaches about 13%, where it then levels off.

While Figure 1 indicates the physical optimal MI is close to 70, the economic optimum will likely occur at a lower MI, since it includes costs. Economic theory suggests that the economic optimum occurs when marginal revenue equals marginal cost (MR=MC). In this case, marginal revenue is in the form of saved expenses from the reduction of one additional dystocia unit and includes the value of the added production from not having that unit of dystocia. Marginal revenue also has the added value of lower culling rates attributed to the decrease in the next unit of dystocia, and any other quantifiable effects of reducing dystocia. Marginal cost is the expense of either purchasing or developing a heifer to a one unit larger MI. These calculations are beyond the scope of this paper but are currently being studied and are left for future publication.

The physical marginal effects on second pregnancy for a one-unit change in MI was estimated using the first derivative of the normal distribution function at the z calculated for that MI. Table 2 shows these marginal changes in dystocia for MIs of 50, 55, 60, 65 and 70.

The Probit regression relating second pregnancy to dystocia indicates there was a statistically significant negative relationship between dystocia and rebreeding. The effect of dystocia on second pregnancy was estimated using the predicted values from the dystocia equation. Results indicated that primiparous cows that had experienced dystocia had an 86% chance of becoming pregnant during the year, while those primiparous cows that had not experienced dystocia had a 95% pregnancy rate.

Conclusion

MI can be used to predict the probability that dystocia will occur in first calf heifers and may potentially provide producers a method of quantifying this relationship to make better decisions on retaining or purchasing replacement heifers.

Also, this research demonstrates that dystocia of the primiparous beef female leads to reduced second pregnancy rates and increased costs. This reduction in pregnancy indicates that breeding smaller MI heifers comes at some additional cost to future production as well as added labor and veterinarian expenses and leads to the conclusion that an economic analysis needs to be completed to illustrate the degree to which the physical relationships affect profitability.

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