Pregnancy rate in Angus heifers

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Summary and Implications

Reproductive records on 3144 Angus heifers were analyzed to determine the genetic basis of female fertility traits. The heritability of pregnancy rate was 0.13, with a range of estimated breeding values of –0.5563 to 0.7308 for sires of heifers. The heritability of first service conception rate was 0.03. The heritability and range of estimated breeding values for pregnancy rate indicate that, while lowly heritable, some improvement in fertility could be made by selecting on heifer pregnancy rate.

Introduction

Reproduction is one of most economically important traits in beef production. As in other livestock species, reproductive traits tend to be lowly heritable. Traditionally, management has been used to maximize herd reproductive efficiency. However, studies have shown that there are genetic differences in fertility. In most breeds there has been no concrete, objective way to evaluate fertility in females.

With the expanded use of AI, there are now large sire groups, and good ties across herds, so it's possible to find differences in lowly heritable traits. There has been a recent interest in selection for fertility traits. For example, recently the Red Angus Association of America began calculating and publishing EPD for heifer pregnancy rate. Heritability estimates for pregnancy percentage in the literature range from virtually 0 to .28. This trait requires a producer to do a pregnancy check on their heifers after the breeding season, and to report the results to the association.

A trait similar to pregnancy rate is first service pregnancy rate. This has an advantage over conception rate because it separates those heifers that settle on the first breeding from those that take many breedings, or settle naturally. This is economically important because of the cost of semen, the labor involved in heat checking and breeding for multiple inseminations, and the difference in the quality and value between AI calves and natural calves. Also, heifers that get pregnant on the first breeding are going to calve earlier, giving them improved chances to breed back the following year. These heifers will also more likely wean a heavier calf than those heifers that conceive later in the season and have a younger calf at weaning. There has been very little work in the literature on the genetics of first service conception rate. One study showed a heritability of .22.

The objective of this project is to study the genetics of female fertility in Angus cattle, and develop an EPD that will help producers identify and select animals with higher genetic merit for female fertility.

Materials and Methods

In cooperation with the American Angus Association, producers from six herds in five states provided breeding information on 3144 heifers. Each record included breeding dates, breeding contemporary groups, service sires, and pregnancy check information. These data were merged with performance and pedigree information, including actual and adjusted birth weights, weaning weights, and yearling weights from the American Angus Association database.

Unlike most performance traits, pregnancy percentage and first service conception rate records are yes/no, or binary. Because of their discrete, rather than continuous, distribution, these types of traits are more difficult to analyze. The binary traits of pregnancy percentage and first service conception rate assume an underlying continuous distribution of fertility that results in those threshold traits. Genetic analysis of these two traits was performed by the software package Matvec. A generalized linear animal model, using the relationship matrix, was fitted. This model included the fixed effects of contemporary group, age of dam, and first service sire, and the covariates of heifer age at the start of breeding, adjusted birth weight, adjusted weaning weight, and adjusted yearling weight. The relationship matrix included four generations of pedigree.

Results and Discussion

The six herds represented in this dataset are located in North Dakota, Kansas, Iowa, Oregon, and Virginia. The distribution of records by herd in shown in Table 1. Farm 5 sent records from 1994-2000. Farm 3 sent records from 1996-2000, and the rest are from 1999 and 2000.

There were a total of 214 sires represented in the dataset. Table 2 shows the number of records by sire. Of the sires with less than five daughters, there are 39 sires with one daughter, 22 sires with two daughters, 29 sires with three daughters, and 14 sires with four daughters. Of sires with more than 50 progeny, there were three with 50-59, three with 60-69, and eight with more than 70 progeny.

The performance of heifers used in this study was similar to breed average. Table 3 shows means, standard deviations, minimums and maximums for actual and

adjusted birth weight, weaning weight, and yearling weight and the yearling gain for the heifers. Angus averages for heifers for adjusted birth weight, weaning weight, and yearling weight were 77, 570, and 840 lbs, respectively. Performance of the heifers by herd is shown in Table 4. There is some difference between farms in terms of performance, but none of them are unusually high or low. Sire group means for performance are shown in Table 5. These are only sires with ten or more daughters, so the total number of observations is 2467. From the lowest to the highest sire group, there is about 15 lbs difference in adjusted birth weight, 170 lbs difference in adjusted weaning weight, and 230 lbs difference in adjusted yearling weight. There are some very high performing sires, and some that are well below breed average.

Conception rate, or pregnancy percentage was defined as the percentage of heifers pregnant at fall pregnancy check. The overall conception rate in this dataset is 93%. Table 6 shows the conception rate of the six farms. In general, farms 1, 5, and 6 had very good conception rates, with the rest being somewhat lower. Herd 5 had by far the most records, so the overall average was highly influenced by that herd. Sire group means for conception rate is shown in Table 7. This is based on the 67 sires that had ten or more progeny, which is a total of 2615 records. There is a large difference in conception rate between sires, and the extreme sires are not outliers. There are 16 sires with 100% conception rates on progeny groups of more than ten. The largest progeny group with 100% conception rate is from a bull with 37 progeny. He had 37 daughters, and every single one got pregnant. There are 11 sires below 80% conception rate. The distribution of sires by conception rate is shown in Table 8. There are many sires with excellent conception rates, and many that are very poor. Of the 16 sires with 100% conception rate on ten or more daughters, five are represented in at least two herds.

First service conception rate is the percentage of heifers that became pregnant after the first service. To determine this, fetal age at pregnancy check or calving dates were required. Table 9 shows the conception rate of herds broken down by service. There were some differences in management between herds. Herd 4 did one AI only and then used cleanup bulls. Herds 1 and 2 did two AI services, and herds 3 and 6 did three. Herd 5 was very management intensive and performed up to seven AI's on their heifers. The percentage of natural calves was inversely proportional to the number of AIs performed, with herd 5 having very few natural calves born. Similarly to pregnancy percentage, herds 1, 5, and 6 have excellent first service conception rates, with 2, 3, and4 somewhat lower. Table 10 shows the sire group means for the 2615 heifers by sires with ten or more progeny. There are sires whose daughters have very poor first service conception rates, and those that are excellent. Table 11 shows the distribution of sires for first service conception rate. There were 18 sires below 50% first service conception rate, of which six were represented in two or more herds, and 19 sires whose daughters were above 65% first service conception rate, of which nine were represented in two or more herds.

Genetic analysis was performed on pregnancy percentage and first service conception rate. The heritability of pregnancy percentage on the underlying continuous scale was 0.13. Estimated breeding values on the underlying scale ranged from –0.4821 to 0.7793 for heifers, and from –0.5563 to 0.7308 for sires of heifers. This indicates that, while lowly heritable, some improvement in fertility could be made by selecting on heifer pregnancy rate. The heritability of first service conception rate was 0.03. The estimated breeding values on the underlying scale ranged from –0.2582 to 0.3401 for heifers and from –0.3232 to 0.3089 for sires of heifers.

Acknowledgements

The authors would like to acknowledge the American Angus Association for their help and the use of their data, and the producers who are cooperating with this project.

Table 1. Distribution of records by herd.

Herd	n
1	130
2	224
3	631
4	235
5	1738
6	181

Table 2. Number of daughter records by sire.

Daughters	Sires	Daughters	Sires
<5	104	20-29	10
5-9	43	30-39	7
10-14	19	40-49	3
15-19	14	>50	14

Table 3. Means, standard deviation, minimums and maximums for adjusted and actual birth weight (BW), weaning weight (WW), and yearling weight (YW).

	Adj BW	Act. BW	Adj.WW	Act. WW	Adj. YW	Act. YW
Mean	82	79	573	536	797	794
S.D.	9.1	10.1	62.9	77.9	82.6	104.2
Min	49	42	312	262	574	560
Max	129	122	790	790	1084	1205

Table 4. Mean adjusted and actual birth weight (BW), weaning weight (WW), and yearling weight (YW) by herd.

Herd	Adj. BW	Act. BW	Adj. WW	Act. WW	Adj. YW	Act. YW
1	82	79	606	606	918	862
2	80	79	570	571	759	780
3	80	77	509	477	775	790
4	80	78	616	567	888	946
5	82	80	583	536	775	753
6	82	80	580	581	846	882

Table 5. Sire group means, standard errors, minimums, and maximums for adjusted and actual birth weight (BW), weaning weight (WW), and yearling weight (YW) for sires with ten or more daughters.

	Adj. BW	Act. BW	Adj. WW	Act. WW	Adj. YW	Act. YW
Mean	82	80	577	541	817	815
SE	4.1	4.8	35.4	45.8	65.0	84.5
Min	74	70	498	437	703	666
Max	90	89	667	644	935	983

Table 6. Percentage pregnant (P) and open (O) by herd.

Herd	n	P%	O%
1	130	96	4
2	224	82	18
3	630	89	11
4	235	75	25
5	1738	97	3
6	181	97	3
All	3138	93	7

Table 7. Sire group means, standard errors, minimums and maximums for percentage pregnant (P) and open (O) (ten or more daughters).

	P%	O%
Mean	90	10
SE	10	10
Min	60	0
Max	100	40

Table 8. Number of sires by conception rate (P%).

P%	Sires	P%	Sires
60-64	2	80-84	7
65-69	0	85-89	5
70-74	4	90-94	11
75-79	5	95-100	32

Table 9. Conception rate of herds by service.

Herd	n	AI1%	AI2%	AI3+%	N%	O%
1	130	66	13	.	17	4
2	224	50	2	.	30	18
3	630	50	20	1	18	11
4	235	45	.	.	30	25
5	1738	65	21	8	3	3
6	181	66	16	1	14	3
All	3138	60	17	4	11	7

AI1% = conception rate after first artificial insemination; AI2% = conception rate after second artificial insemination, AI3+% = conception rate after three or more artificial inseminations, N% = conception rate from natural service, O% = percent open after breeding season

Table 10. Sire group means for conception rate by service (ten or more progeny).

	AI1%	AI2%	AI3%	N%	O%
Mean	56	15	4	15	10
SE	11.7	10.4	4.8	13.0	10.0
Min	29	0	0	0	0
Max	82	42	14	45	40

AI1% = conception rate after first artificial insemination; AI2% = conception rate after second artificial insemination, AI3+% = conception rate after three or more artificial inseminations, N% = conception rate from natural service, O% = percent open after breeding season

Table 11. Number of sires by first service conception rate (AI1%).

AI1%	Sires	AI1%	Sires
20-30	2	60-69	25
30-39	2	70-79	5
40-49	14	80-89	1
50-59	17	90-99	0