Whole herd reporting data from the American Simmental Association as a data source for heifer pregnancy phenotypes

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INTRODUCTION

Reproductive rates in young females determine the amount of calf product sold at weaning in beef production systems and thus is a primary contributor to the financial success of commercial cow-calf enterprises. Commercial producers also risk losing initial investment related to developmental costs of young females that do not breed and stay pregnant. At the seedstock level, genetic progress can be slowed with poor AI conception rates and replacement heifer breeding rates resulting in reduced selection intensity and generation interval. Heifer pregnancy expected progeny difference (EPD) estimates the differences among individuals in the proportion of their daughters that will successfully conceive to calve at 2 yr of age (BIF Guidelines, 2021). Research suggests that heifer pregnancy (HP) is a moderately heritable trait with estimates ranging from 0.14 to 0.53 (Evans et al., 1999; Van Melis et al., 2010; McAllister et al., 2011). Genetic progress for fertility traits in beef cattle has been slowed by low to moderate heritability of reproductive efficiency traits and a lack of reliable field data. Phenotypic data for HP in the form of a heifer exposure inventory include breeding start and end dates, individual exposure status, management group, breeding pasture, disposal information, individual bred status, and a yearling weight contemporary group definition. Additional useful HP information could also include artificial insemination (AI) service dates, AI sire identification, AI protocol, observed natural service, and pregnancy results (BIF Guidelines, 2021). Phenotypic pregnancy observations have been difficult to collect among the major beef cattle breed associations (Speidel et al., 2018). Scrotal circumference (SC) as an indicator trait for HP has been investigated to help improve predictions where HP data are scarce (Evans et al., 1999); however, few genetic evaluations have implemented this methodology and have instead developed standalone genetic predictions for SC. Some breed associations have developed a HP prediction under the assumption that a heifer with a yearling weight observation is assumed to have been exposed and those that report a calf at 2 yr of age were successfully bred to overcome the lack of HP inventory observations (Speidel and Enns, 2015).

Inventory-based whole herd reporting (WHR) has been suggested as an enticing source of information on a range of economically relevant traits, notably reproductive efficiency traits (Hough and Ponder, 2001; Cammack et al., 2009). Whole herd reporting is the collection and reporting of production information on every cow along with the performance data of every calf raised through weaning in a production system. The benefits of WHR include the calculation of unbiased growth predictions in addition to the collection of reproductive performance data on entire female contemporaries.
in a production system. Industry adoption of WHR processes in breed association registry services was historically slow among U.S. breed associations since first proposed in the late 1990s. However, many breed associations now offer robust WHR programs, and several organizations even require mandatory WHR from members to take advantage of the unbiased growth predictions and ability to predict EPD for traits like Stayability (Krymowski, 2019). These reporting programs for breed associations accumulate many productivity and disposal information that are predominantly unused within National Cattle Evaluations (NCE) today. These productivity and disposal codes provide an opportunity to understand specific reasons animals leave a herd early and what proportion issues such as infertility, structural soundness, or udder failure are prevalent in a breed-specific population. The objective of this study is to identify the merit of using WHR productivity and disposal information as a data source to establish heifer pregnancy phenotypes when heifer inventory data were not reported.

**MATERIALS AND METHODS**

Presently, there are no standard practices for the implementation and use of WHR data in the beef industry. Many WHR programs lack precise descriptions of productivity and disposal reasoning, with few organizations enforcing WHR data submission compliance. The data used in this study were a subset of a larger HP dataset \( (n = 740,423) \) provided by International Genetic Solutions (IGS), where data from American Simmental Association (ASA) females enrolled in the Total Herd Enrollment (THE) inventory-reporting program were queried. Females were first eligible to be on THE inventory when they turned 2 yr of age, so females whose birth year plus 2 yr were included in this study \( (n = 400,469) \). The ASA did not have an avenue for members to submit heifer inventory information such as heifer exposure, breeding dates, or breeding pasture data. Using THE status, productivity codes, and evaluating enrollment status, a methodology was developed to assign heifer exposure (EXP) and bred status (BRED) phenotypes. A list of THE enrollment, productivity, and disposal codes and descriptions can be found in Tables 1 through 3.

All females approaching 2 yr of age were automatically included on an ASA member’s preliminary inventory every year/season. Spring herds were classified as dams that will calve between January 1 and June 30 of a given year. Fall herds were classified as dams that will calve between July 1 and December 31 of a given year. Heifers that stayed on a member’s inventory must have had an enrollment status code indicating her status and intent to stay in the herd (Table 1). Heifers that did not stay on a member’s preliminary inventory must have a disposal status code indicating her reason for leaving the herd (Table 3).

In some cases, animals that have an initial inventory disposal status code were also given a productivity code. Users were able to assign up to 2 disposal codes per dam, with the first being a “primary code” and the second being an “additional code.” Only primary disposal codes were evaluated in this study. Each code combination was evaluated to establish a heifer pregnancy record satisfying:

**Table 1.** Code and description of American Simmental Association Total Herd Enrolment heifer enrolment codes

| Enrolment Code | Description                          |
|----------------|--------------------------------------|
| 0              | Cow bred to calve during the season  |
| 1              | Heifer bred to calve during the season |
| 2              | Not exposed—moved to next season     |
| 3              | Exposed and failed to conceive—moved to next season |
| 4              | Exposed and failed to conceive—moved to next year |
| 5              | Embryo transfer donor                |
| 6              | Embryo transfer recipient            |
| 44             | Not exposed—moved to next year       |

**Table 2.** Code and description of American Simmental Association Total Herd Enrolment heifer productivity codes

| Productivity Code | Description                                      |
|-------------------|--------------------------------------------------|
| 1                 | Calf/calves stillborn                           |
| 2                 | Aborted                                         |
| 3                 | Not exposed to calve in given season/year       |
| 4                 | Cow calved                                      |
| 5                 | Embryo transfer donor                           |
| 6                 | Embryo transfer recipient                       |
| 7                 | Exposed and failed to conceive—moved to next season |
| 8                 | Exposed and failed to conceive—moved to next year |
| 9                 | Exposed and failed to conceive—removed from herd |
| 10                | Calving interval overlaps season (Dec–Jan; Jun–Jul) |
| 11                | Bred—but sold, removed or died prior to calving |
| 12                | Cow calved—calf not found intact or at all      |
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1) whether a female on enrollment was exposed and given the opportunity to become pregnant (EXP = yes or no), and 2) whether a female was successfully bred or failed to conceive (BRED = yes or no). The default for both EXP and bred status BRED was n = no.

Data on THE females were only included on animals born 2009 or after since ASA THE processes were not enforced for compliance prior to 2009. Compliance was a process established in 2009 to ensure timely data submission and accurate reporting of dams among THE herds. Participants were required to provide either a disposal code or productivity code for dams on inventory by the deadline (spring = February 15, fall = August 15) for each season enrollment. When a disposal or productivity code was not provided for a dam on inventory, participants were considered “non-compliant,” and no transactions could be processed until a status code was provided and females were given a late-enrollment fee. Participants’ enrollment for ASA spring THE opened October 15 to December 15 and productivity/disposal codes on enrolled females were regularly reported the following April through October, indicating that there was a 5- to 10-mo delay in productivity/disposal code reporting on enrolled females.

### RESULTS AND DISCUSSION

The assignment of EXP and BRED phenotypes on THE females was determined using both the status and productivity codes. A total of 400,469 THE heifers were enrolled or disposed since 2009. Data counts for EXP and BRED designations are provided in Table 4. All females given a 0, 2, 5, 6, or 44 enrollment code were removed from this dataset and given an unsuccessful EXP observation as a heifer.

Females that were enrolled in THE inventory (n = 240,861) had 71 unique enrollment and productivity code combinations. The largest category of heifers that received a successful observation for EXP and BRED came from those that had an enrollment code of 1 and a productivity code of 4, identifying those females that were enrolled on inventory as a heifer bred to calve during the season of enrollment and successfully calved (n = 176,534). Heifers that received an enrollment code of 1 and productivity codes of 1, 2, 4, 7, 8, 9, 10, 11, or 12 were given a successful EXP observation, but only heifers receiving productivity of 1, 2, 4, 11, or 12 were assigned a successful BRED observation. There were 9,017 females that were exposed but failed to conceive (productivity = 7, 8, or 9) if being enrolled as a 1. A small portion of females were sold as bred (n = 10,554) and some were reported to have aborted, had a stillborn, or calved but no calf was found (n = 1,484, 1,220, and 761, respectively). Heifers that received an enrollment code of 3 or 4 were assigned a successful EXP observation, but an unsuccessful BRED observation (n = 3,207). There were a total of 203,206 heifers assigned a successful EXP observation and a known BRED observation among this group.

Primary reasons for heifer disposal are described in Table 5. The majority of heifer inventory

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**Table 4. Designation counts of American Simmental Association Total Herd Enrollment (THE) females for enrollment and exposed status**

| Designation                                      | Count     |
|--------------------------------------------------|-----------|
| Total number of THE heifers since 2009           | 400,469   |
| Total number of heifers enrolled since 2009      | 240,861   |
| Total number of heifers not enrolled since 2009  | 159,608   |
| Number of heifers not enrolled and not exposed   | 139,632   |
| Number of heifers not enrolled but exposed       | 19,976    |
| Number of heifers enrolled and exposed           | 203,173   |
| Number of heifers enrolled but not exposed       | 37,688    |
| Number of heifers exposed and with a bred status | 223,149   |
| Number of heifers enrolled but without productivity—herd drop out | 16,603   |
disposals were from selling open/bred heifers or herd reduction, reflecting 62% of all heifer disposals. There were a large percentage of females sold with registration certifications transferred, possibly opening the opportunity for an additional population to be evaluated for a HP phenotype assignment. However, determining the enterprise where breeding took place may be difficult to identify without additional investigation or added tracking on those females sold with registration certifications transferred. The production or performance of young stock was also evaluated and cause for removal, reflecting 13% of heifer disposals. This is encouraging, suggesting that many producers participating in THE are using performance predictions in their culling decisions compared to culling based off appearance which reflects 7% of heifer disposals.

Females that were removed from inventory and not given an initial enrollment code were assigned successful and unsuccessful EXP and BRED observations based on their disposal and productivity codes. In practice, females that were removed from THE should not have received a subsequent productivity code; however, in some cases, both are identified. There were 80 unique combinations of female groups that were reported with a disposal code and also had a productivity code. All females with disposal codes apart from 60, 61, 64, 65, and 67 were removed from this dataset and assigned an unsuccessful EXP and BRED status, regardless if a subsequent productivity code could possibly identify a female had calved successfully. Since productivity code reporting timeframes vary, there is not a great way to track whether the female was given the opportunity to become pregnant in a given enrollment season nor given the opportunity to become pregnant among her contemporaries. Females that received a disposal code of 60, regardless of productivity, were assigned a successful EXP observation and an unsuccessful BRED observation \( (n = 19,163) \). Females that either aborted, lost a calf at birth, or died in calving and removed from the herd for these reasons were included in this dataset. Females receiving disposal codes of 61, 64, 65, or 67 were all assigned successful observations for EXP and BRED \( (n = 813) \).

A total of 31,816 females were identified since 2009 as having had the opportunity to become pregnant but failed to succeed in that pregnancy. The percentage of reproductive failures within this population of Simmental heifers was 14%. This proportion is consistent with the national average found in 2017, where the National Animal Health Monitoring System evaluated data across 24 of the major U.S. cow-calf states and reported 83% of heifers and 94% of cows calved.

Table 5. Proportion of disposal reasons among American Simmental Association Total Herd Enrolment (THE) heifers since 2009

| Disposal code | Description                                               | Record count | Proportion of disposals |
|---------------|-----------------------------------------------------------|--------------|-------------------------|
| 60            | Exposed and failed to conceive                            | 19,163       | 12.0%                   |
| 61            | Aborted                                                   | 410          | 0.3%                    |
| 62            | Age                                                       | 482          | 0.3%                    |
| 63            | Appearance                                                | 11,708       | 7.3%                    |
| 64            | Calf loss at calving                                      | 165          | 0.1%                    |
| 65            | Calf loss post calving                                    | 121          | 0.1%                    |
| 66            | Color                                                     | 268          | 0.2%                    |
| 67            | Died—calving                                             | 117          | 0.1%                    |
| 68            | Died—other                                               | 2,599        | 1.6%                    |
| 69            | Died—sickness/disease                                     | 675          | 0.4%                    |
| 70            | Disposition                                               | 2,570        | 1.6%                    |
| 71            | Herd reduction                                            | 41,158       | 25.8%                   |
| 72            | Hoof condition                                            | 332          | 0.2%                    |
| 73            | Horned                                                    | 54           | 0.0%                    |
| 74            | Injury                                                    | 394          | 0.2%                    |
| 75            | Production/performance                                    | 20,279       | 12.7%                   |
| 76            | Prolapse                                                  | 99           | 0.1%                    |
| 77            | Sickness/disease                                          | 238          | 0.1%                    |
| 78            | Sold, breeding purposes, paper not transferred            | 40,640       | 25.5%                   |
| 79            | Sold, breeding purposes, paper transferred                | 17,431       | 10.9%                   |
| 80            | Structural soundness                                      | 504          | 0.3%                    |
| 81            | Udder quality                                             | 27           | 0.0%                    |
| 82            | Genetic defect status cow bred to calve during the season | 174          | 0.1%                    |
when given the opportunity to become pregnant in 2017 (USDA, 2020). It appears this methodology of assigning HP phenotypes from WHR codes appropriately identified reproductive efficiencies consistent with the national beef cattle average and could be a useful tool for breed associations to capture HP data when heifer inventory data were not reported. Prevatt et al. (2018) found that a reduction of 2% in reproductive infertilities could reduce economic loss by $1,800 per 100 head annually for a beef cattle enterprise.

**IMPLICATIONS**

Development of a heifer pregnancy EPD would be warranted for selection to improve the reproductive fitness of replacement heifers in Simmental cattle. Further investigation into the effectiveness of WHR and the application of records is needed before NCE EPD can be provided to Simmental breeders.

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