Considerations Related to Breed or Biological Type

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KEYWORDS

• Breed • Biological type • Crossbreeding • Heterosis • Complementarity
• Expected progeny difference (EPD) • Genomics

KEY POINTS

- Age at puberty is variable among breeds and biological types (British<Continental<*Bos indicus*–influenced) and is moderately heritable.
- Heterosis (also known as hybrid vigor) occurs when the performance of the crossbred progeny for a specific trait is greater than the average of their parents.
- Heterosis effects are significant and important for fitness and survival traits such as longevity, lifetime production, and reproduction rate.
- Complementarity results from crossing breeds of different but complementary biological types.
- Properly designed crossbreeding systems based on heterosis and complementarity generally out-produce those based on straightbreeding in productivity, but the challenge is to manage the program and to produce progeny that meet market specifications and acceptance.
- Before making a commitment to any breed(s) or breeding system, the logistics, costs (including opportunity costs), benefits, and feasibility should be objectively evaluated in the context of the environment, feed resources, and marketing system.
- Expected progeny difference genetic merit estimates for heifer pregnancy, stayability, and scrotal circumference are available for some breeds and have all been positively associated with female fertility.
- Selection for replacement heifers is based on their readiness and ability to conceive in the proposed breeding season, which places indirect selection on dam fertility, because fertile cows tend to conceive early and generate those early heifers that are selected as replacements.
- Emerging reproductive and genomic technologies offer exciting possibilities for innovative approaches to heifer selection and breeding program design, but as with all new technologies, enthusiasm needs to be tempered with a realistic evaluation of the costs and expected benefits.

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INTRODUCTION

From a heifer development perspective, age at puberty can be an important factor as to whether a heifer conceives and delivers a calf by 2 years of age. Because this trait is variable among breeds and moderately (0.1–0.67) heritable,[1] breed selection and type of breeding system can greatly influence this trait. Many other factors come into play when determining the ideal breed or combination of breeds and breeding program to best match genetic resources to the environment and marketing system.

Biological type is a term used to describe breeds of cattle that share common characteristics. Among beef cattle breeds these include the terms: British (eg, Angus, Hereford, South Devon), Continental European (eg, Charolais, Gelbvieh, Limousin, Maine-Anjou, Simmental), and *Bos indicus*–influenced (eg, Brangus, Santa Gertrudis) breeds. More than 60 breeds of beef cattle are present in the United States; however, a few breeds make up most genetics used in the United States for commercial beef production. The optimal breed, or combination of breeds, for any given location is governed by several factors, including:

- Resources (size of the herd, facilities, labor, management ability)
- Target market
- Quantity and quality of feedstuffs available
- Climate
- Breed complementarity
- Cost and availability of purebred livestock

To optimize reproductive rate in the cow herd, genetic potential for environmental stress, mature size, and milk production should be matched to the environment and available feed resources. The reproduction potential of cows with large size and high milk declines if the environment and feed resources are insufficient to meet the higher requirements for maintenance and lactation.

The US Meat Animal Research Center (MARC) characterized more than 30 sire breeds for a wide variety of economically relevant traits, including growth rate and mature size, percent retail yield, age at puberty, and milk production. The breeds evaluated by MARC grouped by age at puberty are shown in **Table 1**.[2]

Heifers sired by breeds that are heaviest at 400 days of age tend to be the oldest at puberty. Conversely, heifers sired by breeds with smaller mature size tend to reach puberty earlier. However, some large breeds that have been selected for milk production reach puberty at a comparatively young age. Cattle that have some *Bos indicus* influence generally mature at a later age. Correlations between milk production and age at puberty are –0.87 among *Bos taurus* breeds and –0.19 including *Bos indicus* breeds, whereas correlations between mature size and age at puberty are 0.57 and 0.25, respectively.[1]

Purebred Hereford and purebred Angus heifers had greater ages at puberty (389.5 $\pm$ 12.9 and 372.2 $\pm$ 10.0 days, respectively)[3] than Hereford or Angus heifers derived from dams crossed with Charolais, Jersey, South Devon, Simmental, and Limousin sires, showing that both breed and breeding system contribute to age at puberty. A summary of the literature from a variety of studies on reported ages and weights at puberty by breed is shown in **Table 2**. Heterosis effects can also significantly reduce the interval from calving to first estrus (–2.66 days), average date of conception (–2.8 days), and increase the first-service conception (6.6%), and calf crop weaned (6.4%) to natural service breeding for a 65-day season when comparing straightbred Hereford, Angus, and Shorthorn heifers to reciprocal cross heifers of the same breeds.[4]