AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2016 – 2018

TITLE: Impacts of post-weaning growth rate on reproductive development and maternal ability (milk production) of replacement beef heifers

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EXECUTIVE SUMMARY: The Oregon beef industry is mainly comprised by cow-calf operations, and represents the largest agriculture commodity in the state. A critical factor for overall efficiency in cow-calf production systems is the inclusion of replacement heifers into the herd. For optimal economic return and lifetime productivity, replacement beef heifers should attain puberty by 12 months of age, conceive by 15 months of age, and calve as 2 year-olds. In this optimal scenario, replacement heifers will only provide economical returns to producers when they wean their first calf, at approximately 3 years of age. Given that $1,000 is the typical cost to develop a 2-year-old pregnant heifer ready to calve (mostly due to nutritional inputs) and approximately 100,000 replacement heifers are introduced annually into the Oregon cow-calf industry, more than 50 million dollars are invested every year, with no immediate return, into heifer development programs by Oregon cow-calf producers. These expenses are increased by 80% when replacement heifers fail to conceive during their first breeding season, become pregnant for the first time as 2 year-olds, and wean their first calf at 4 years of age. Therefore, management strategies that maximize the number of replacement heifers pubertal by 12 months of age and pregnant as yearlings are vital to the productivity/profitability of the Oregon's beef industry.

Puberty is generally achieved when heifers reach 55-60% of their mature body weight. Hence, weaning weight and post-weaning growth rate are factors that directly determine reproductive success of beef heifers. As an example, data from the EOARC-Burns indicates that in heifers weaned with 500 lbs at 7 months of age, each 1 lb/day increase in post-weaning average daily gain decreases heifer age at puberty by 35 days (range from 0.5 to 3.0 lbs/day of post-weaning gain). However, growth rates greater than 2 lbs/day, which may be needed when 7 month-old heifers are weaned at 450 lbs or less, can be detrimental to heifer lifetime maternal performance. Research with dairy heifers showed that daily gain greater than 2 lbs/day causes excessive fat accumulation in mammary tissues, which in turn impairs heifer mammary gland development and future milk yield. In beef cattle, research in this area is still limited and was only conducted in early-weaned heifers (3-4 months of age), which suggested that post-weaning gains greater than 2 lbs/day decreased heifer milk production by 20% and weaning weight of their calves by 10%.

OBJECTIVES: Expose replacement beef heifers weaned at 7 months of age to 3 levels of post-weaning growth rate (1, 1.5, and 2 lbs/day), and evaluate their puberty attainment, pregnancy rates, mammary gland development, as well as their milk production and calf weaning weight

as first-calf heifers. *This research is highly relevant to Oregon beef producers by testing the interactions among growth rates, puberty attainment, and mammary development in beef heifers weaned at the traditional age and exposed to nutritional management typical of Oregon cow-calf systems*

PROCEDURES: This research was divided into a post-weaning phase (day 0 to 230), breeding and gestation phase (day 231 to 560), and first-calf heifer phase (day 561 to 770), and conducted at the OSU - EOARC Burns. Currently, the research is in the first-calf heifer phase, as all heifers are expected to calve by the end of March 2018. This research will be completed in September 2018.

Seventy-two Angus × Hereford heifers were weaned at 7 months of age (September 2016; day 0). Heifers were randomly allocated to receive 1 of 3 treatments: 1) diet to stimulate average daily gain of 1 lb/day from day 0 to 230 (**LG**), 2) diet to stimulate average daily gain of 1.5 lbs/day from day 0 to 230 (**MG**), and 3) diet to stimulate average daily gain of 2 lbs/day from day 0 to 230 (**HG**). Diets are based on grass-alfalfa hay and supplemental distiller's grain. During the breeding and gestation phase (day 231 to 560 of the experiment), heifers were re-allocated into 1 pasture and offered the same diet (grass-alfalfa hay and supplemental distiller's grain) to yield an average daily gain of 1.5 lbs/day. From day 231 to 281 of this phase, heifers were exposed to Angus bulls for breeding. During the first-calf heifer phase (d 561 to 770), heifers and their calves are being managed in a single group, and heifers offered forage-based diets (either hay during the winter and pastures during spring and summer) to yield an average daily gain of 1.0 lb/day. On day 771, calves will be weaned and the research will be completed.

Heifer body weight are being and will be obtained at the beginning and end of each phase (days 0, 230, 560, and 770) for average daily gain calculation. During the post-weaning phase (day 0 to 230), blood samples were collected weekly (Wednesday) to determine onset of puberty using progesterone concentrations. Heifers were considered pubertal once progesterone concentrations are greater than 1.0 ng/mL for 2 consecutive weeks. Selected blood samples were also analyzed for concentrations of hormones and metabolites associated with nutrient metabolism, such as IGF-I (somatomedin). Body weight from heifer's offspring will be recorded at birth, 45 days of life, 90 days of life, and at weaning. Heifer milk production will be assessed 45 after the end of the calving season via the weigh-suckle-weigh method. Samples of the mammary gland from each heifer will be collected via biopsy after the weigh-suckle-weigh procedure, and analyzed for its physical characteristics (i.e. fat content) and DNA-based regulators of mammary cell development.

SIGNIFICANT ACCOMPLISHMENTS:

As designed, initial body weight was similar across all treatments (Table 1). On day 230, body weight and growth rate differed between treatments as designed (Table 1). Plasma concentrations of IGF-I, a physiological marker of growth and reproductive development, were the greatest in HG heifers, intermediate in MG heifers, and the lowest in LG heifers (Table 1). Puberty attainment by day 230 was increased in HG heifers, and similar between LG and MG heifers (Figure 1; Table 1).

Table 1. Heifer growth rate during the post-weaning phase (day 0 to 230)

Item	LG	MG	HG	*P-value*
Initial body weight, day 0	514	514	514	0.99
Body weight, day 230	679[c]	765[b]	838[a]	< 0.01
Growth rate, lbs/day	0.90[c]	1.37[b]	1.77[a]	< 0.01
Plasma IGF-I, ng/mL	131.8[c]	177.2[b]	200.2[a]	< 0.01
Pubertal heifers by day 230, %	56.5[b]	62.5[b]	87.5[a]	< 0.01

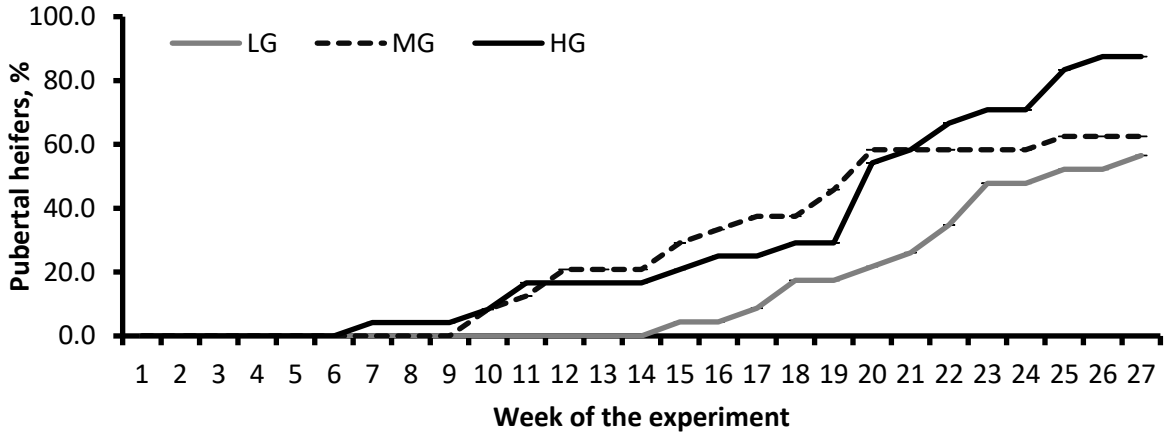

Figure 1. Puberty attainment during the post-weaning phase (day 0 to 230)

BENEFITS & IMPACT: To date, results indicate that our treatments were successful and lead to the expected changes in puberty attainment. The major focus of this experiment, however, is on heifer milk production and offspring growth, which will be completed by September 2018.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: None

FUTURE FUNDING POSSIBILITIES: USDA-AFRI grant to investigate the role of growth rate on mammary development, focusing on hyperplastic and hypertrophy growth of mammary cells as well as fat deposition in the mammary gland.