Animal Science News

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Beyond Breeding: How Genetics and Epigenetics Shape Cattle Performance

In genetics, we often use a simple equation (P = G + E) to explain an animal's performance (P), which is determined by both its genetics (G) and the environment (E). While genetics provide the blueprint, the environment shapes how traits are expressed. In cattle production, genetics (nature) and environment (nurture) work together to determine performance. With this in mind, our research program within the Department of Animal Sciences focuses on understanding the interaction between genetics and environment to enhance cattle production efficiency.

A major aspect of our research is its interdisciplinary approach, bridging nutrition, physiology, reproduction, genetics, and genomics to investigate biological questions with practical implications on cattle production. One of our key research goals is to identify biomarkers – biological indicators – that can predict the reproductive success of heifers. By studying hormones, genes, and other molecular signals in heifers, we aim to develop reliable markers that can help producers select animals more likely to conceive and maintain pregnancies. Identifying these biomarkers will allow for earlier and more precise decisions in herd management, leading to improved fertility rates and overall herd efficiency. Additionally, we focus on the role of nutritional management of the breeding herd in fetal programming and how these factors impact long-term performance.

By selecting sires and dams with desirable traits and high breeding values, producers can improve traits like fertility and growth. However, have you ever wondered why animals with similar genetic potential, raised under the same conditions, perform differently? Why do some heifers in the same developmental breeding program become pregnant while others don't? These are the kinds of questions that our research aims to answer. Today, we understand that genetics and environmental factors (nutrition, management, health, etc.) play a key role in shaping cattle productivity, especially through epigenetics. Think of epigenetics as a switch that controls how genes are turned "on" or "off" during critical periods of development, including in the womb. In cattle, epigenetic modifications can have far-reaching effects. For instance, a calf exposed to inadequate nutrition during gestation may experience changes in how specific genes function, potentially leading to poor growth and development later in life. Epigenetics shows us that it is not just the genes we pass on to the next generation that matter. How we feed, handle, and care for our cattle can have as much impact on their performance as the genes they inherit.

Although feed costs are the most significant expense for producers, nutritional management is key for herd health and productivity. It affects both immediate performance and long-term outcomes. Our collaborative research with the North Dakota State University has shown that providing a commercial vitamin and mineral supplement throughout gestation to beef heifers positively affected the offspring. Calves born to supplemented heifers (113 grams per heifer per day of the vitamin and mineral supplement) increased the hepatic concentration of selenium, copper, zinc, and cobalt, which are essential for immune function, fertility, and growth functions. Interestingly, there were no differences in the birth weight of these female calves. However, from weaning through 15 months of age, calves born to supplemented dams were approximately 38 pounds heavier, on average, than non-supplemented ones. Another study with a similar approach focused on the molecular effects showed that genes involved in immune response, nutrient transport, and metabolism were affected (turned "on" or "off") in the calves' jejunum based on the dam's diet (supplemented or not). The jejunum is the main site of absorption of nutrients. These results, coupled with recent literature, show that specific vitamins and minerals set up the functioning of the genome through the modulation of mineral and vitamin-dependent genes. This is also true for the overall nutrition of the herd. Providing the required amount of nutrients is essential for proper fetal development. It is important to note that these calves had a similar genetic background (crossbred Angus), but a basic management strategy, such as providing proper mineral and vitamin supplements during gestation, can set the stage for better performance later in life. The research questions we are currently pursuing are: Are the effects on the expression of these genes by programming the function of organs or the metabolism of the offspring inherited across generations? If so, the decisions we make today can influence the current generation of cattle and future ones.

To maximize the potential of your herd, you need to go beyond breeding. While genetics lay the foundation for success, proper management, including nutrition, determines whether that genetic potential will be realized. By paying close attention to genetic selection, nutrition, and herd management,

producers can help ensure their cattle reach optimal performance, not just in this generation but in the ones to come. This is the work we do!

If you are curious to know more, feel free to reach out. You can also follow our work through our Livestock Research Report.

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https://aub.ie/ALA23	http://aub.ie/ALreport22