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Scientist Continues Pioneering Dairy Research at UD

Food, making a living, computers, farmers, Apollo 13, dairy cows . . . what do these disparate concepts have in common? Answer: Dr. Jim Maas, the college's new dairy professor and one of the new group of scientists utilizing mechanistic mathematical modeling. Maas, who is interested in milk production and composition, is motivated by some basic beliefs about agriculture and research.

"You can come up with all sorts of information that's quite useful biologically, but it may or may not have an application," says Maas. "If you look at the problems confronting present-day agriculture, many are economic. The question then becomes how to apply the science and technology to meet those challenges and to improve production and efficiency."

"I study ruminants – animals with four stomachs that have a tremendous capacity to convert things that are of no nutritional value to humans into highly nutritious food products," he adds. "There is nothing more fundamental than food production. No society can survive or prosper without a constant supply of highly nutritious food. Advanced technology means nothing if you don't have something to eat."

Having grown up on a beef farm in Ontario, Canada, Maas knows about the challenges farmers face and the value of good science – two factors that have shaped his current research into mechanistic mathematical modeling. Amino acids are key here.

Milk protein is synthesized from individual amino acids. "The number and activity of amino acid transporters may limit the rate of milk protein synthesis in the mammary gland of a lactating dairy cow," explains Maas. "If we can identify the control points that limit the rate of milk protein synthesis, we can tailor milk composition to market requirements, which will help farmers run more financially successful operations."

According to Maas, application of mechanistic mathematical modeling techniques is relatively new in the area of agricultural research. Traditional reductionist research methods tend to break a system down to its individual components, then through experimentation, determine how each of the individual components work.

In contrast to this reductionist method (looking at the pieces), mechanistic modeling takes reductionist-derived data and knowledge and uses it to synthesize a model. Using the model, scientists can predict changes in outputs when input conditions are altered by studying the behavior of the entire system; for example, the quantity and composition of milk produced in the mammary gland of a dairy cow.

It was early in his career as a district manager for Ralston Purina, a livestock feed manufacturer, that Maas decided there had to be a better way to manage cows to optimize milk production.

"I realized just how little information we had to do the job we were trying to do – balance rations," Maas recalls.

Inspired by the pioneering work of Dr. Lee Baldwin at the University of California at Davis, and Professor Jim France, Reading University, England, Maas begins by making flowcharts of the biochemical processes occurring within the dairy cow mammary gland.

To produce the model, he uses a modeling language called Advanced Continuous Simulation Language, coincidentally the same modeling software used to help bring back Apollo 13. In this way he can simulate conditions within a cow's mammary gland, analyze the model predictions, and estimate which specific set of conditions results in the greatest changes in milk protein output.

Sensitivity analyses suggest where the biological control points are. Once the control points are made clear, practical techniques of altering the conditions can be tested. Model results are then compared with actual results, and the model revised and updated.

"What's interesting about this research is that the same basic principles apply to all tissues," he explains. "I'm looking at it in mammary tissue, but all cells act the same. The pharmaceutical industry has shown interest in the same approach because many drugs are transported across membranes by the same types of transporters."

Ultimately, Maas hopes his research will help people, especially those working in the business of agriculture. He foresees a time when farmers will use software packages to alter milk composition to satisfy every-changing market needs and achieve profitable, efficient production.