



Feed efficiency in dairy cows: From Science to nutritional strategies for improved health, reproduction, and farm profitability

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Compiled answers from Dr. José Eduardo P. Santos and Dr. Fabio Lima

SECTION 1: Dr. José Eduardo P. Santos

This section features answers from Dr. José Eduardo P. Santos, DVM, M.Sc., Ph.D., Professor in the Department of Animal Sciences at the University of Florida. His research and extension efforts aim to improve dairy production efficiency, with a focus on nutrition and reproductive performance around the peripartum period—two key factors that affect milk yield and cow longevity. His work bridges cellular biology, physiology, and applied nutrition, resulting in practical technologies widely adopted by dairy producers.

HIGHER ENERGY INTAKE ABOVE MAINTENANCE DIDN'T INCREASE MILK ENERGY OUTPUT. WHY IS THAT ENERGY USED LESS EFFICIENTLY?

Dr. José Eduardo P. Santos: Cows were fed the same diet; intake varied naturally. Some consumed more than predicted, others less. Efficiency differences likely stem from variability in maintenance requirements, digestion, and nutrient utilization.

HOW DO GROSS FEED EFFICIENCY AND RESIDUAL FEED INTAKE (RFI) DIFFER, AND WHY IS RFI CONSIDERED SUPERIOR?

Dr. José Eduardo P. Santos: Gross efficiency is ECM per kg DM intake. RFI accounts for predicted intake and allows for genetic selection, though it's impractical to measure on-farm. Genomic values for RFI and "feed saved" are now available and help identify more efficient animals.

CAN NUTRIENT LOSSES VIA FECES, GAS, AND HEAT BE REDUCED ONLY THROUGH GENETICS?

Dr. José Eduardo P. Santos: No. Both genetics and dietary management help. Forage quality, fatty acid inclusion, amino acid balancing, and disease prevention all contribute to efficiency.

WHAT IS "DILUTION OF MAINTENANCE" AND HOW DOES IT IMPROVE FEED EFFICIENCY?

Dr. José Eduardo P. Santos: Maintenance needs are constant; increasing milk output spreads these fixed costs over more production, improving efficiency. High-producing cows allocate a smaller proportion of nutrients to maintenance.

IN AN RFI STUDY, COWS WITH SIMILAR PRODUCTION DIFFERED IN INTAKE. CAN THIS BE EXPLAINED?

Dr. José Eduardo P. Santos: Yes. RFI is residualized from predictors like BW and ECM. Cows may differ in digestion or metabolic efficiency. These individual differences aren't captured by energy balance equations.

NEGATIVE RFI COWS HAD BETTER REPRODUCTION. WHY MIGHT THIS BE?

Dr. José Eduardo P. Santos: Although associations, not causations, were observed, more efficient cows (negative RFI) may allocate resources better for reproduction. The mechanisms are not yet fully understood.



SECTION 1: Dr. José Eduardo P. Santos

HOW PRACTICAL IS IT TO USE THE FEED SAVED INDEX COMMERCIALLY?

Dr. José Eduardo P. Santos: Very. Since 2021, Holstein bulls include RFI and Feed Saved values. These are integrated into major indices like Lifetime Net Merit, guiding producers toward more efficient animals.

DOES SELECTING FOR LARGER COWS REDUCE FEED EFFICIENCY?

Dr. José Eduardo P. Santos: Yes. Larger body size increases maintenance needs. There's a positive correlation between BW composite and RFI—larger cows are less efficient.

CAN YOU SUMMARIZE THE FINDINGS ON DCAD AND FEED EFFICIENCY?

Dr. José Eduardo P. Santos: Acidogenic prepartum diets reduce hypocalcemia, metritis, and improve yield—all boosting efficiency. Diseases lower feed efficiency by reducing production and increasing culling risk.

SHOULD DCAD DIETS BE USED FOR NULLIPAROUS COWS TOO?

Dr. José Eduardo P. Santos: No. Trials show no benefit in heifers. Nulliparous cows have higher MP needs and shouldn't receive acidogenic diets. Separate diets are recommended.

DO YOU RECOMMEND SEPARATE CLOSE-UP DIETS FOR PRIMIPAROUS AND MULTIPAROUS COWS?

Dr. José Eduardo P. Santos: Yes. Their nutrient needs and DCAD responses differ significantly.

DO IONIC CALCIUM GELS IMPROVE MILK PRODUCTION AND SNF?

Dr. José Eduardo P. Santos: Not directly. Most oral calcium supplements use salts (e.g., CaCl_2), not ionic Ca. These can be beneficial but should be used with caution, not universally.

WHAT'S THE PRACTICAL ADVICE FOR BALANCING ESSENTIAL AMINO ACIDS?

Dr. José Eduardo P. Santos: Optimize microbial protein, then complement with RUP sources and protected amino acids. Methionine and lysine are top priorities, especially in early lactation.

RDP/RUP SUGGESTIONS FOR CLOSE-UP COWS?

Dr. José Eduardo P. Santos: Nulliparous: ~14% CP, 11% MP; include high RUP sources. Parous: 12–13% CP, 9% MP; soybean or canola meal is usually sufficient.

WHY IS CORN GLUTEN MEAL HIGH IN RUP?

Dr. José Eduardo P. Santos: It's heat-treated during processing, reducing rumen degradability. It's rich in methionine but low in lysine and tryptophan.

ONE PIECE OF ADVICE FOR NUTRITIONISTS WORKING ON FEED EFFICIENCY?

Dr. José Eduardo P. Santos: Focus on forage quality, cow comfort, and preventing periparturient disease—these are the most impactful areas for efficiency and profitability.

WATCH JOSÉ EDUARDO P. SANTOS' WEBINAR:





SECTION 2: Dr. Fabio Lima

The following section includes expert responses from Dr. Fabio Lima, DVM, M.Sc., Ph.D., Associate Professor of Livestock Health & Theriogenology at the School of Veterinary Medicine, University of California, Davis. His research program focuses on improving the health, performance, and fertility of dairy cows, with an emphasis on nutritional strategies to enhance immunity and reproductive function during the transition period. Among his current investigations is the role of dairy cow genomics in modulating the heritable rumen microbiome and its impact on milk production and feed efficiency.

YOU SHARED HOW COMMON EARLY POSTPARTUM DISEASES ARE—WITH ALMOST A THIRD OF COWS BEING AFFECTED. FROM A PRACTICAL NUTRITIONIST’S POINT OF VIEW, WHAT SHOULD OUR TOP PRIORITY BE TO HELP REDUCE THE RISK OF THESE EARLY FRESH COW DISEASES?

Dr. Fabio Lima: From my perspective, the top priorities are to ensure that diets are formulated meticulously to help prevent metabolic disorders such as hypocalcemia and hyperketonemia and optimize cow comfort. Transition period strategies include feeding additional chloride salts, targeting -100 mEq/kg for multiparous cows in the three weeks pre-calving, optimizing protein and limiting amino acids like methionine, and supplementing with ingredients like rumen-protected choline (RPC). Without proper cow comfort, diet alone will not be effective.

WE SAW THAT PHOSPHATIDYLCHOLINE LEVELS DIP AROUND CALVING. COULD THIS AFFECT VLDL SYNTHESIS IN THE LIVER AND, AS A RESULT, IMPACT LIVER HEALTH IN DAIRY COWS?

Dr. Fabio Lima: Yes, reduced phosphatidylcholine likely decreases VLDL availability and impairs liver health. Cows with low phosphatidylcholine may struggle to export triglycerides from the liver, increasing the risk of hepatic lipidosis. RPC, as a precursor, has been shown to enhance VLDL synthesis and reduce liver triglyceride accumulation.

YOU MENTIONED THAT HIGHER BHB LEVELS, OR HYPERKETONEMIA, NEGATIVELY AFFECT REPRODUCTION, ESPECIALLY IN LOWER-PRODUCING COWS. WHY MIGHT BHBA HAVE A STRONGER IMPACT ON THESE COWS?

Dr. Fabio Lima: Lower-yielding cows may be less metabolically adaptable and have lower feed intake, making them more vulnerable to hyperketonemia. While high producers may compensate and adapt better, lower-yielding cows show greater reproductive impairment under similar metabolic stress.

YOU SHOWED THAT DISEASE CAN LOWER EMBRYO QUALITY AND DEVELOPMENT. ARE THERE ANY SPECIFIC DIETARY STRATEGIES THAT CAN HELP SUPPORT REPRODUCTIVE FUNCTION OR IMPROVE EMBRYO DEVELOPMENT?

Dr. Fabio Lima: Preventing disease through proper nutrition is key. However, a study from Wisconsin showed that cows with disease but supplemented with rumen-protected methionine had improved reproductive performance compared to unsupplemented, diseased cows.



SECTION 2: Dr. Fabio Lima

YOU ALSO TALKED ABOUT USING FATTY ACIDS, ESPECIALLY LONG-CHAIN ONES, TO SUPPORT FERTILITY. WHICH FATTY ACIDS OR FAT SOURCES SHOULD BE PRIORITIZED IN EARLY LACTATION?

Dr. Fabio Lima: Diets should include 1.0 to 1.5% fatty acids to reach 4-5% of diet DM. Omega-3s (n3) are beneficial, as they can increase pregnancy rates and reduce losses.

HOW DO YOU CONNECT THE DOTS BETWEEN CHOLINE AND FEED EFFICIENCY IN DAIRY COWS?

Dr. Fabio Lima: RPC supplementation consistently increases energy- and fat-corrected milk with relatively smaller increases in intake, suggesting improved nutrient partitioning. Mechanisms may include better liver health, enhanced lipid availability, and possibly effects on the gut microbiome.

EXTENDING CHOLINE SUPPLEMENTATION BEYOND THE TRANSITION PHASE ALSO HAD POSITIVE EFFECTS ON REPRODUCTION. CAN YOU EXPLAIN THE FINDINGS AND MECHANISMS?

Dr. Fabio Lima: Continuing RPC supplementation may raise blood choline during key reproductive phases, supporting steroid hormone synthesis. This includes estradiol (for estrus behavior) and progesterone (for maternal recognition of pregnancy), both crucial to reproductive success.

YOU MENTIONED THE RUMEN MICROBIOME'S ROLE IN FEED EFFICIENCY. HOW MIGHT THIS SHAPE FUTURE DIET FORMULATION?

Dr. Fabio Lima: The field is growing, with more use of direct-fed microbials and recognition that common ingredients influence the microbiome. This will lead to more targeted diets to improve microbial-driven efficiency.

HOW SHOULD WE BALANCE ESSENTIAL AMINO ACIDS LIKE METHIONINE AND LYSINE IN REAL-WORLD DIETS TO BOOST FEED EFFICIENCY?

Dr. Fabio Lima: Diets should meet 100% of metabolizable methionine and maintain a 3:1 lysine-to-methionine ratio. Other amino acids like histidine can be below 100%.

ONE PIECE OF ADVICE FOR NUTRITIONISTS TO IMPROVE FEED EFFICIENCY, HEALTH, REPRODUCTION, AND PROFITABILITY?

Dr. Fabio Lima: Do not ignore feed efficiency in diet formulation—it can provide the highest ROI for producers.

WATCH FABIO LIMA'S WEBINAR:



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