

# Spartan Dairy

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Fall 2022 Vol.2 No.3



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**Dairy at MSU**

**@DairyMsu**

**Dairy at MSU**

# MSU Dairy Funding

MSU receives state funding for updated dairy, greenhouse facilities

With the passage of higher education spending by the Michigan legislature, Michigan State University will receive \$53 million in state funding to update the university's dairy and greenhouse facilities.

**“We’re so grateful to our partners who advocated for us to receive this funding: the agricultural commodity groups, legislators and industry leaders,” said Kelly Millenbah, interim dean of the College of Agriculture and Natural Resources. “Generations of our students will benefit from this investment. When we have improved, state-of-the-art facilities, we’ll be able to do more in support of Michigan’s farmers and consumers.”**

“I can’t begin to express how much this means to MSU and even more importantly, how much the transformational research made possible by this infrastructure investment will benefit Michigan farmers, their futures and livelihoods,” said George Smith, director of MSU AgBioResearch. “It’s been a collaborative approach and one that we could never have endeavored on our own. Much appreciation is extended to the Michigan legislature, commodity organizations and our agricultural partners for assisting and providing support for these much-needed new research facilities, upgrades and improvements.”

The greenhouse complexes, which were largely constructed before 1978, serve over 60 faculty researchers, around 400 students, and staff from three MSU colleges. The research and outreach that takes place in the greenhouses provides Michigan’s diverse growers with state-specific insights into soil, climate, pests and weeds.

The Dairy Cattle Teaching and Research Center is over 60 years old, and a 2021 fire destroyed a dairy feed barn, underscoring the need for a modernized, safe facility. Dairy is the leading contributor to Michigan’s agricultural economy, and the state dairy industry relies on MSU to train future farm managers and advance research in support of both production and environmental sustainability.



“As a land-grant institution, we’re here to provide education and support to the people of Michigan,” said Quentin Tyler, director of MSU Extension. “These updates will allow us to continue this outreach work into the future.”

*By Kelly Kussmaul*

**Use this QR code to learn more about the need for a new MSU Dairy:**



# Dairy Spotlight

Paola Bacigalupo Sanguesa and Wei Liao



**Paola Bacigalupo Sanguesa:**  
**Dairy Extension Educator**

I am from a small town in the central region of Chile, where agriculture is the main economic activity. Although I grew up surrounded by all types of farms, my interest in dairy started later in my life.

I chose veterinary medicine as my career, with no clear idea of where I would go and what I would end up doing after graduation. But after my first 2 years of vet school, I knew my future was with dairy cattle. After I got my DVM, I did a year-long internship at a Colorado dairy. I then went back to Chile only to return to Colorado, now to pursue a Master's degree at Colorado State University focused on epidemiology of dairy cows.

Until that point, I enjoyed working with anything calf- and calving-related and avoided parlors and udders at any cost. That quickly changed after I learned about and got involved with the work of Dr. Erskine and his team on milking efficiency; now 9 out of 10 of my farm visits are milking-related. This new (to me) line of work led me back to school to get a PhD, where I am focused on the long-term impact of delayed milk let down, also known as bimodal milking, on milk production.

I am writing this as I celebrate my 5th anniversary of moving to Michigan as a dairy educator with MSU Extension, and all I can say is that it was one of the best decisions I've made.



**Wei Liao:**  
**Professor and Director**  
**of Anaerobic Digestion**  
**Research and Education**  
**Center**

I was born and grew up in Xinjiang province, China (Northwest China). I lived in an urban area during my entire childhood, and had no ideas about animal agriculture whatsoever except occasionally visiting ranches in the Tian Shan mountain to see cattle and ride horses. I got my B.S degree in fermentation engineering from Jiangnan University near Shanghai and then worked as a brewing engineer for several years before moving to the U.S. to pursue a Ph.D. in biosystems and agricultural engineering. I was still doing fermentation research, though the feedstock was changed from malt/rice to animal manure!

My Ph.D. study was about the value-added utilization of dairy manure, mainly focusing on biologically converting the carbohydrates in manure to fatty acids. I started to gain knowledge of dairy operations. I then learned that dairy manure contains approximately 45% of the gross carbon in forage feeds that cows consume, the largest carbon sink on a dairy farm (higher than milk). It was at this time that I decided to focus my career on research and development of organic residue/waste utilization.

In the past 15 years of my career at MSU, I established an integrated research program that brings ecology, microbiology, engineering, and economics together to develop novel farm-based biorefining solutions for organic waste management (including dairy manure). Current research projects include: farm-based renewable

electric vehicle charging solutions for a climate-smart U.S. dairy industry; integrated farm-based biorefining; solar-bio-based solutions to convert liquid organic waste sources into energy and clean water; and a one-carbon platform of food/fuel/chemical production. I am also extensively involved in international research and education activities on renewable energy and environmental sustainability, with research in Africa, Asia, Latin America, and Europe.

More information about my research and MSU ADREC can be found at <https://www.egr.msu.edu/liao/> and <https://www.egr.msu.edu/bae/adrec/>.

# News & Updates

All things dairy at MSU

## New Parlor at MSU Dairy

Like many commercial farms, the milking parlor at the MSU Dairy has a few years under its belt. Despite the new facility on the horizon, frequent electrical failures and lost data made it untenable to try to continue to do research with the existing equipment for another 3 years.

This summer, with the help of Michigan Dairy Tech and Afimilk, the parlor was fitted with all new wiring, flow meters, and AfiLab, which provides flow-through analysis of milk in real time. MSU faculty and staff are already using the new system to potentially generate more accurate research data.



## Jerry Kehr New South Campus Animal Farms Veterinarian



MSU recently welcomed Dr. Jerry Kehr as the new veterinarian for the South Campus Animal Farms. He will be working with the farms and assisting with regulatory requirements. He has been in private practice for just over 30 years after graduating from Purdue in 1992. Originally from Indiana, he practiced briefly in western New York, then back in Indiana for about 9 years before moving to Michigan in 2002. He and his wife live in Portland and have 2 sons in college. During his free time, he enjoys fishing, gardening, sporting events, and being involved in his local community church in Portland.

*By Jolene Bott*

## Dairy Judging Teams Travel to Maryland

In September the MSU Dairy Judging team, along with 4-H members and alumni volunteers, travelled to the Maryland State Fair. They sidelined multiple dairy shows, working together to improve on their dairy judging skills. The group then took a trip to Washington, D.C. to visit memorials and museums.



For more information, visit:  
<https://www.canr.msu.edu/dairyjudging/>

## Nominations are open for the 2023 Dairy Farm of the Year Award



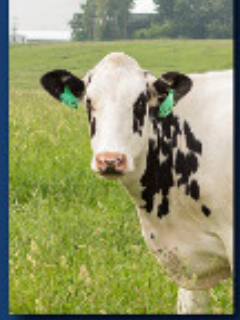
The Michigan State University Department of Animal Science is seeking nominations for the 2023 Dairy Farm of the Year Award. Since 1958, the Dairy Farm of the Year Award has been given to a farmer, farm partners or family that has distinguished themselves through excellence in dairy farming and outstanding involvement in the industry or their community. Information about the award, a list of past recipients and the nomination form can be accessed online. Even if not all information requested on the form is available, nominations are still welcome.

*Nominations are due to Miriam Weber Nielsen, [maw@msu.edu](mailto:maw@msu.edu), chair of the selection committee, by Oct. 15.*

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# News & Updates

All things dairy at MSU



## Michigan Selected to Join Dairy Business Builder Grants Program; MDARD Encouraging Dairy Industry to Apply for New Grant Opportunities

*Michigan dairy farmers, manufacturers, and processors encouraged to apply  
for new grant opportunities up to \$100,000*

MDARD announced Michigan is joining the federal Dairy Business Builder Grants program, which aims to support small- to medium-sized dairy businesses in diversifying on-farm activity, creating value-added products, enhancing dairy by-products, and creating or enhancing dairy export programs. Dairy farmers, manufacturers, and processors in Michigan can apply now until November 10 at 5:00 p.m. (CT) for a new round of Dairy Business Builder grants through the Dairy Business Innovation Alliance (DBIA), a partnership between the Wisconsin Cheese Makers Association (WCMA) and the Center for Dairy Research at the University of Wisconsin – Madison (CDR). The reimbursement grants of up to \$100,000 each aim to support small- to medium-sized dairy businesses.

*Application materials and resources are available online at [cdr.wisc.edu/dbia](http://cdr.wisc.edu/dbia). Successful applicants will be notified by December 15, 2022. Questions may be directed to DBIA Program Coordinator Emily Slatter at [eslatter@cdr.wisc.edu](mailto:eslatter@cdr.wisc.edu) or (608) 301-7751. Farms looking for help from MSU can contact the Farm Management team: <https://www.canr.msu.edu/farm-management/experts>*

## Ukraine farming, from revolution to revolution: A personal experience

From the demise of the collective farms during the Soviet years, Ukraine emerged after independence in 1991 with largely untapped agricultural potential that was limited only by resources. The central planning of the Soviet times had proven to be inefficient and ineffective. After independence, farmers could make their own decisions and investments, and farms progressed greatly.

Ukraine carried the residual of the Soviet times for decades, whether it was outdated, poor quality facilities or undemocratic business practices and outright corruption. Corruption marred the 2004 election and prompted the Orange Revolution of late 2004. I arrived for my first trip to Ukraine in Kyiv on the last days of 2004 and heard much of the public revolt against a fraudulent election and the demand for true democracy.

Ten years later, in 2014, along with two of my Michigan State University Extension colleagues, I was invited to speak at the Ukrainian Dairy Congress, a national two-day dairy conference. We were excited to learn about the Ukrainian dairy industry and to share some of our knowledge with them. That February, I flew into Kyiv a week earlier than my colleagues planned in order to spend time with friends I had made there in past visits. In that week, the Maidan Revolution occurred.

The Maidan Revolution was in many ways about whether Ukraine would be subservient to Russia or would become more European. President Yanukovich chose Russia in betrayal over the desire of the parliament and the people. In that week, massive protests caused Yanukovich to flee the country and the parliament voted to remove him from office.

Once gone, his estate was opened to the public for the first time. I was one of hundreds of thousands that walked around it, amazed at the waste of public dollars that fed his whims while many of his people went without. As I stood outside of his residence and looked around, the only Ukrainian flag I saw was one that was raised by the protesters and the realization came to me that the President had not displayed the Ukrainian flag. His heart was not for this country.

*By Phil Durst*

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# News & Updates

All things dairy at MSU

## Michigan Dairy Expo and Michigan 4-H Youth Dairy Days Recap

Michigan Dairy Expo and Michigan 4-H Youth Dairy Days returned to the MSU Pavilion for Agriculture and Livestock Education July 18-23, 2022. 96 youth from 16 counties participated in at least one educational event during the week. The week opened with showmanship, breed shows, and the state 4-H Dairy Management Contest on Tuesday; state youth Dairy Judging Contest on Wednesday; and closed with the state 4-H Dairy Quiz Bowl on Thursday. Thursday also included a celebratory picnic to honor achievements of the week and look forward to a fall of national events. Almost 200 cattle in seven breed shows were exhibited during the open shows on Friday.

Immediately following Dairy Days, coaches host additional workouts to continue skill building. The summer closes with Dairy Judging Bootcamp where potential 4-H, post-secondary, and collegiate team members travel to the Maryland State Fair over Labor Day weekend. Youth and students judge 30 classes of cattle, give a dozen sets of oral reason, watch and evaluate cattle shows, and visit memorials on the National Mall, Smithsonian Natural History Museum, and more in the greater Washington, D.C. area. The fall is busy with three big events: The All-American Dairy Show, World Dairy Expo, and the North American International Livestock Exposition (NAILE). Each of the national events offers different learning and educational experiences for 4-H youth and MSU students.



4-H members earn the invitation to participate in national contests based on their success during Dairy Days. Youth from the Dairy Dreamers Club will represent Michigan at the National Junior Dairy Management Contest at the All-American Dairy Show and in NAILE's 4-H Dairy Educational Experience. Clinton, Isabella, Livingston, Mecosta, Newaygo, and Tuscola county youth will be on national 4-H judging teams this year. Keep an eye on the 4-H Dairy Cattle Production and Management and MSU Dairy Judging websites for updates throughout the year.

# News & Updates

All things dairy at MSU

## AMERICAN DAIRY SCIENCE ASSOCIATION ANNUAL MEETING

The American Dairy Science Association (ADSA) is an international organization of educators, scientists, and industry representatives who are committed to advancing the dairy industry. The ADSA holds an annual meeting, and after 2 years of online meetings, it returned to an in-person format in June 2022. A total of 1,678 people from 45 countries registered for the meeting, of which 1,377 attended in person. These attendees delivered a total of 1,070 oral or poster presentations over 4 days.

The annual meeting includes symposia and workshops that enable in-depth discussion of the latest scientific findings and dairy industry issues on a global platform. Of note, MSU's Dr. Mike Vandehaar wrapped up his second consecutive year as overall program chair for the meeting, which is a tremendous contribution to the association. His contributions, however, were not the only Spartan imprint on the meeting. Dozens of MSU faculty and students participated in the meeting, contributing to more than 50 presentations.



Here are some of the MSU highlights from ADSA 2022.

### MICHIGAN STATE UNIVERSITY DAIRY GRADUATE STUDENTS

Several MSU dairy graduate students competed in scientific presentation contests at the meeting, and they performed exceptionally well, capturing 6 of the 18 placings in dairy production, including 3 out of 4 first-place awards in the graduate student division. Congratulations to these award winners:

**National Milk Producers Federation Graduate Student Paper Presentation Contest in Dairy Production Award - PhD Division**  
1st Place: Thainá Minela

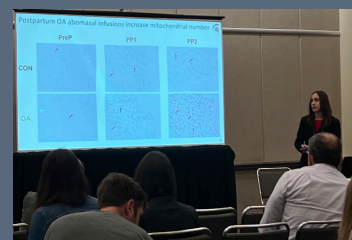
**National Milk Producers Federation Graduate Student Paper Presentation Contest in Dairy Production Award - MS Division**  
1st Place: Ursula Abou-Rjeileh

**Purina Animal Nutrition Graduate Student Poster Contest - MS Division**  
1st Place: Alisson Da Mota Santos  
3rd Place: Kristen Gallagher

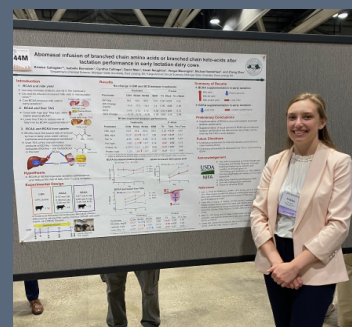
**Undergraduate Original Research Poster Presentation**  
2nd Place: Paige Gibb  
3rd Place: Samantha McBeth



Samantha McBeth, Alisson Da Mota Santos, Thainá Minela, Paige Gibb



Ursula Abou-Rjeileh



Kristen Gallagher



SCAN HERE FOR VIDEO HIGHLIGHTS FROM ADSA WITH MSU STUDENT PRESENTERS

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# News & Updates

All things dairy at MSU



## **MIKE ALLEN RECOGNITION SYMPOSIUM: INTEGRATING THE CONTROL OF ENERGY INTAKE AND PARTITIONING INTO RATION FORMULATION**

Dr. Michael Allen retired from MSU as a University Distinguished Professor in January 2021 after spending 33 years on the faculty of the Department of Animal Science. This symposium was held to honor his body of work, which led to his recognition as a Fellow of ADSA in 2019.

Over his career, Dr. Mike Allen was never one to shy away from confrontation, with only one intent: to improve the rigor of dairy science. In the title of this symposium, the word "Integrating" was used intentionally; Dr. Allen successfully integrates digestion characteristics of feeds, rumen function, metabolism, hormonal control, and energy dynamics into a complete package. Presentations by former students of Dr. Allen - Drs. Masahito Oba, Barry Bradford, and Paola Piantoni - were followed by concluding talk by Dr. Allen, to a standing-room-only crowd.

The day was concluded with a retirement reception attended by dozens of former students and over 100 other well-wishers. It was a fitting tribute to highly impactful Spartan.



## **ÁNGEL ABUELO: MSU VETERINARIAN AWARDED THE CARGILL ANIMAL NUTRITION YOUNG SCIENTIST AWARD BY THE AMERICAN DAIRY SCIENCE ASSOCIATION**

The Cargill Animal Nutrition Young Scientist Award was created to recognize outstanding research by young dairy production scientists during the first 10 years of their professional career. The winner must have demonstrated outstanding research in dairy cattle production areas within five years immediately prior to the year of the award, published original research work, and been a member of ADSA for at least five successive years.

Ángel Abuelo is an associate professor at MSU College of Veterinary Medicine. He obtained his veterinary and PhD degrees from the University of Santiago de Compostela (Spain). His research focuses on strategies to enhance immunity during the neonatal and periparturient periods in dairy cattle. At MSU, he maintains federally funded research and extension programs, for which he has secured more than \$4.3 million as principal investigator (PI) or co-PI since 2018. Abuelo has published 49 peer-reviewed articles and presented 25 national and international invited talks. He also contributes to veterinary student clinical training and provides continuing education to veterinarians.



## **LORRAINE SORDILLO SYMPOSIUM: DETERMINANTS AND CONSEQUENCES OF SYSTEMIC INFLAMMATION DURING THE DAIRY COW TRANSITION PERIOD**

This symposium provided a tribute to and a spotlight on the contributions of Dr. Lorraine Sordillo-Gandy, a former MSU professor who passed away in 2021. Speakers included MSU's Dr. Andres Contreras (shown at left) as well as respected scientists from other institutions who are building on the foundational work from Dr. Sordillo's 35-year career.



# Management Tips

MSU Dairy Extension Team



Victor Malacco

## Breeding and raising the right cow for automatic milking systems

The increasing adoption of automatic milking systems (AMS) by farms worldwide is a reality that will likely continue in the following years. Reductions in labor availability and increases in wage rates across the U.S. are driving higher adoption of automation in all farm sizes. However, in addition to investment cost, uncertainties about the transitioning process, changes in management practices, and the potential for increased voluntary culling rates of cows that do not adjust to the new system often make farmers second guess the decision to implement AMS.

Advancements in technology have made AMS reliable. Data from a Canadian survey of farms that went from conventional milking systems to AMS showed that, on average, just 2% of animals needed to be culled because of behavior or conformational characteristics, such as udder conformation. However, more opportunities exist to improve productivity and efficiency in AMS herds by adjusting breeding goals and management. This is especially important for large herds, in which some of these adaptations may pose logistical challenges.

Several conformational and behavioral characteristics will make a cow suitable for milking in automated milking systems. In the perfect world, we would like to have a cow:

- With good udder conformation, making it easy for the robot to attach the milking unit and clean the teats.
- With good feet and legs that do not prevent the cow from voluntarily getting to the robot.

*By Victor Malacco*

[View full article here](#)



## Should dairies utilize grasses to increase forage NDF digestibility?

In our previous article, we discussed how to make use of in-vitro NDF digestibility (ivNDFD) feed analyses. Using ivNDFD for comparisons within a forage class is worthwhile, and research has demonstrated that increasing ivNDFD of forages is associated with greater dry matter intake (DMI) and milk production. The increase in DMI and milk yield is greatest in high-producing cows. Connecting forage ivNDFD and performance has led to speculation that utilizing cool season grasses to increase ivNDFD of forage blends may increase DMI and milk yield, therefore increasing the value of the forage.

There are agronomic and feed inventory reasons for growing grasses and legumes together but mixing grasses with alfalfa as a shortcut to increase DMI and milk production is a flawed strategy. A key reason is that digestion processes are different for grasses vs. legumes. First, legumes pass through the rumen more rapidly than grasses because of how the plant particles break down. Legumes, being more brittle, tend to break down into cube-shaped fragments that can exit the rumen relatively quicker, whereas grasses are degraded to long thin strands that take longer to pass out of the rumen, while potentially also entrapping other small particles within the rumen. Therefore, even though the ivNDFD of the forage mix may increase with the addition of grass, the DMI and milk production potential does not necessarily increase. Increasing the proportion of grasses slows passage rate, which will generally cancel out the benefit of increased ivNDFD on DMI. It is important to remember that when considering ivNDFD and its effects on milk yield and DMI, we must only compare ivNDFD within forage type.

*By Barry Bradford, Kim Cassida, and Kirby Krogstad*

[View full article here](#)



# Management Tips

MSU Dairy Extension Team



Phil Durst

## Moving to zero bovine leukemia virus – A project summary

With most dairy herds infected with bovine leukemia virus (BLV), and an average prevalence greater than 40%, we wondered how we could help herd owners eliminate the disease in their herds and what it would take to do that. We also wanted to know if we could inexpensively monitor herds that were not infected.

In the “Moving to Zero” BLV project, funded in 2021 with a Michigan Alliance for Animal Agriculture (M-AAA) grant, we selected herds that, in a previous study, were shown to have either no BLV or low BLV prevalence. Our plan was to use qPCR test results to identify for herd owners and managers, the cows with the highest BLV proviral loads, the supershedders that maintain and spread the disease in their herds. We did not compel anyone to cull animals.

Available funds limited the number of cows enrolled in the project. We recruited 10 herds to participate with an average of 241 cows per herd (range: 62 – 414). Initially, an ELISA test (milk or blood from nonlactating cows) was conducted on every cow in the herd. Four of the herds tested negative for BLV. The remaining six had prevalence levels ranging from 3 – 22%. Blood was drawn from all ELISA-positive cows for the SS1 qPCR test at CentralStar Labs. The qPCR test reports the ratio of DNA from BLV to DNA of the host. Therefore, a qPCR result of 2 would indicate twice as much BLV DNA than host DNA. CentralStar Labs categorizes qPCR test reports as high (>1.0), medium (0.5-1.0), low (<0.5) and undetected virus. Test results were reported to herd owners or managers.

By Phil Durst

[View full article here](#)



Doctoral student Maddy Sokacz draws blood from a cow for qPCR testing

## Online farm stress training is free and open to the public

What is farm stress and how can you help? With the current uncertainties the farming community is facing, it's likely that you or a fellow farmer could experience effects of stress. You or someone you know may be struggling with stress, anxiety, depression, burnout, indecision, or thoughts of suicide. Would you know what to say or do if you were personally experiencing or confronted with those situations?

Recognizing the high levels of stress affecting America's farmers and ranchers, Michigan State University Extension has partnered with others from the USDA's Cooperative Extension System, Farm Credit, American Farm Bureau Federation, and National Farmers Union to create a free online course that is now available and open to the public.

### About the Course

The free online course brings together the knowledge of agricultural conditions and evidence-based approaches in behavioral health to help people recognize the signs of stress and better equip farmers and the agricultural community with tools and resources to help in time of need. The course has been designed to provide an opportunity to interactively learn about farm stress and how to help others manage stress through an online platform that consists of three units; Managing Stress, Communicating with Distressed Farmers, and Suicide Awareness. The engaging content is self-paced and offers several voice-over slide presentations, videos, and downloadable resources.

By Remington Rice, Tanner Derror, Cheryl Eschbach, Gwyn Shelle

[View full article here](#)

## Rural Resilience: Farm Stress Training



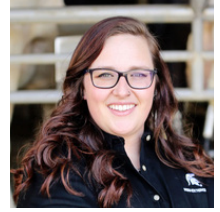
MICHIGAN STATE UNIVERSITY | Extension

ILLINOIS EXTENSION

National Farmers Union | FARM CREDIT

# Management Tips

MSU Dairy Extension Team



Cora Okkema

## Important changes to note in the dairy calf and heifer association's 2020 gold standards

The Dairy Calf and Heifer Association (DCHA) has created the Gold Standards, a set of recommendations to help producers take the best care of their youngstock with actionable benchmarks. Starting in 2011, the DCHA has made this information readily accessible to their members with an easy-to-read guide. The second edition was released in 2016 and the third in 2020.

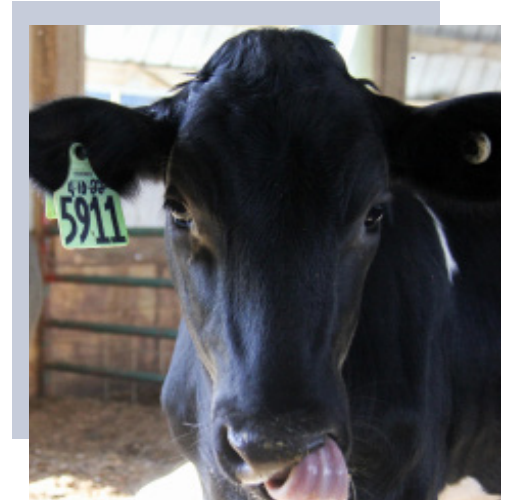
### Some notable changes from the 2016 to the 2020 edition include:

There were a variety of changes and additions regarding colostrum.

- The recommended time for refrigerated colostrum to be stored before use has been reduced from 48hrs to 24hrs from time of harvest. This is to prevent feeding colostrum that has undesirable levels of bacteria.
- To heat-treat colostrum, pasteurize it at 140 degrees F for 60 minutes. For heat-treated colostrum, the target for Standard Plate Count (SPC) is set at <20,000 CFU/mL and Coliforms is set at <100 CFU/mL.
- Monthly screening for quality colostrum was suggested by the DCHA to maintain colostrum quality and overall health of calves.
- With the introduction of commercial colostrum replacer, the DCHA has acknowledged this product as a viable substitute when quality maternal colostrum is not available. Colostrum replacer should have no less than 300g IgG.

By Cora Okkema

[View full article here](#)



## Mycotoxins in Michigan silage corn: Status and lessons learned

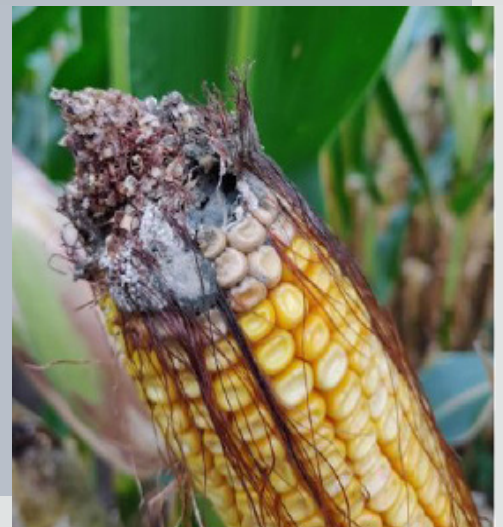
Mycotoxins in corn grain have long been studied and measured, but the presence of mycotoxins in silage corn has largely been ignored. Yet, the impact of mycotoxins on cattle will be from the total mycotoxin load in the ration, not just that from one component. Many dairy rations rely heavily on silage corn, therefore, quality issues in this important feed will be magnified in production aspects.

Fungi such as *Aspergillus*, *Fusarium*, *Penicillium* and *Gibberella* spp. in corn plants cause accumulation of mycotoxins (toxic secondary metabolites) in corn ear and stalk. Cool and wet weather conditions around silking of corn tends to be favorable for growth of *Fusarium graminearum* and may cause high deoxynivalenol (DON or vomitoxin) accumulation. Feeding by birds, animals and ear damaging insects such as western bean cutworm (WBC) and European corn borer (ECB) can provide easy entry for the fungus and intensify infections. Increased flight of these insects and the failure of cry1F (a type of Bt protein) against WBC have aggravated ear injuries and aided infections.

Mycotoxins result in metabolic disruptions in livestock that eat contaminated feed, hence putting their lives and productivity at risk. Some toxins, especially DON, zearalenone (ZON) and fumonisins cause feed rejections leading to loss in milk production, hormonal imbalance, reduced reproductive performance and in some cases the death of animals. Mycotoxins can have serious economic consequences on farms if present in sufficient concentrations. But mycotoxins do not occur in isolation. Very often, various mycotoxins co-occur and their impacts on the health of livestock may be synergistic. This makes it difficult to determine safe levels (thresholds) for individual mycotoxins.

By Harkirat Kaur, Phil Durst, Philip Kaatz, Martin Mangual and Maninder Singh

[View full article here](#)



# Research Drill Down

Angel Abuelo, Arpita Nayak, Katy Kesler, Hannah Carlson, Faith Cullens-Nobis

## Re-Evaluating Antioxidants for Dairy Cattle

### Introduction

Dairy cattle can succumb to illnesses at any given time. However, the majority of diseases take place around two clusters: (1) the time around calving and (2) the first few weeks of a calf's life. These periods of increased disease susceptibility are attributed to dysfunctional immune responses in these animals. A key factor responsible for the development of these diseases is oxidative stress (OS), which results from the imbalance between the production of free radicals, also known as reactive oxygen/nitrogen species (RONS), and the availability of antioxidant defenses that are needed to reduce RONS-induced cellular damage.

Studies performed in the last decade clearly indicate that dairy cows experience OS around the time of calving and the first few weeks of age. OS diminishes functional capabilities of immune cells and increases the animals' susceptibility to diseases. In this article, we will review some of the work our group has been doing on characterizing OS in transition cows and newborn calves, as well as strategies to mitigate its impact through antioxidant supplementation.

*Arpita Nayak with calves*



### Oxidants and Anti-oxidants

Oxidants are substances that are able to oxidize other molecules. Free radicals are oxidizing agents with one or more unpaired electrons in the outer electron shell, making them highly reactive. RONS are the most abundant free radicals in biological systems, and are formed normally as by-products of cellular metabolism. RONS are essential for cell physiological processes, and play a key role in production of cell signals and the destruction of pathogens by the immune system. When produced in excess, however, RONS can harm the cells, leading to loss of cell function and tissue damage.

To prevent impaired biological function due to RONS damage to cellular structures, living organisms have developed a complex antioxidant defense system. Antioxidants can be divided into three major groups: enzymatic antioxidants, nonenzymatic protein antioxidants, and nonenzymatic low-molecular-weight antioxidants. Of these, the nonenzymatic antioxidants are primarily responsible for the antioxidant capacity of plasma. For example, lipid-soluble  $\alpha$ -tocopherol (vitamin E) protects cell membranes from lipid peroxidation; ascorbic acid (vitamin C) and  $\beta$ -carotene can neutralize free radicals and enhance the antioxidative effect of vitamin E. Similarly, several trace elements, such as copper, manganese, selenium, and zinc, can protect the body from RONS either directly or as cofactors of antioxidant enzymes.

### Oxidative stress vs. Oxidant status

These terms have been used interchangeably in the past. However, we now know that there is a clear difference between OS and oxidant status that should be considered. Oxidant status refers to the balance between the production of RONS and the total antioxidant capacity, also known as reduction-oxidation (redox) balance. Conversely, OS refers to the oxidative damage resulting from the imbalance between oxidants and antioxidants. OS includes oxidative modification of cellular macromolecules, cell death, as well as structural tissue damage (Figure 1).

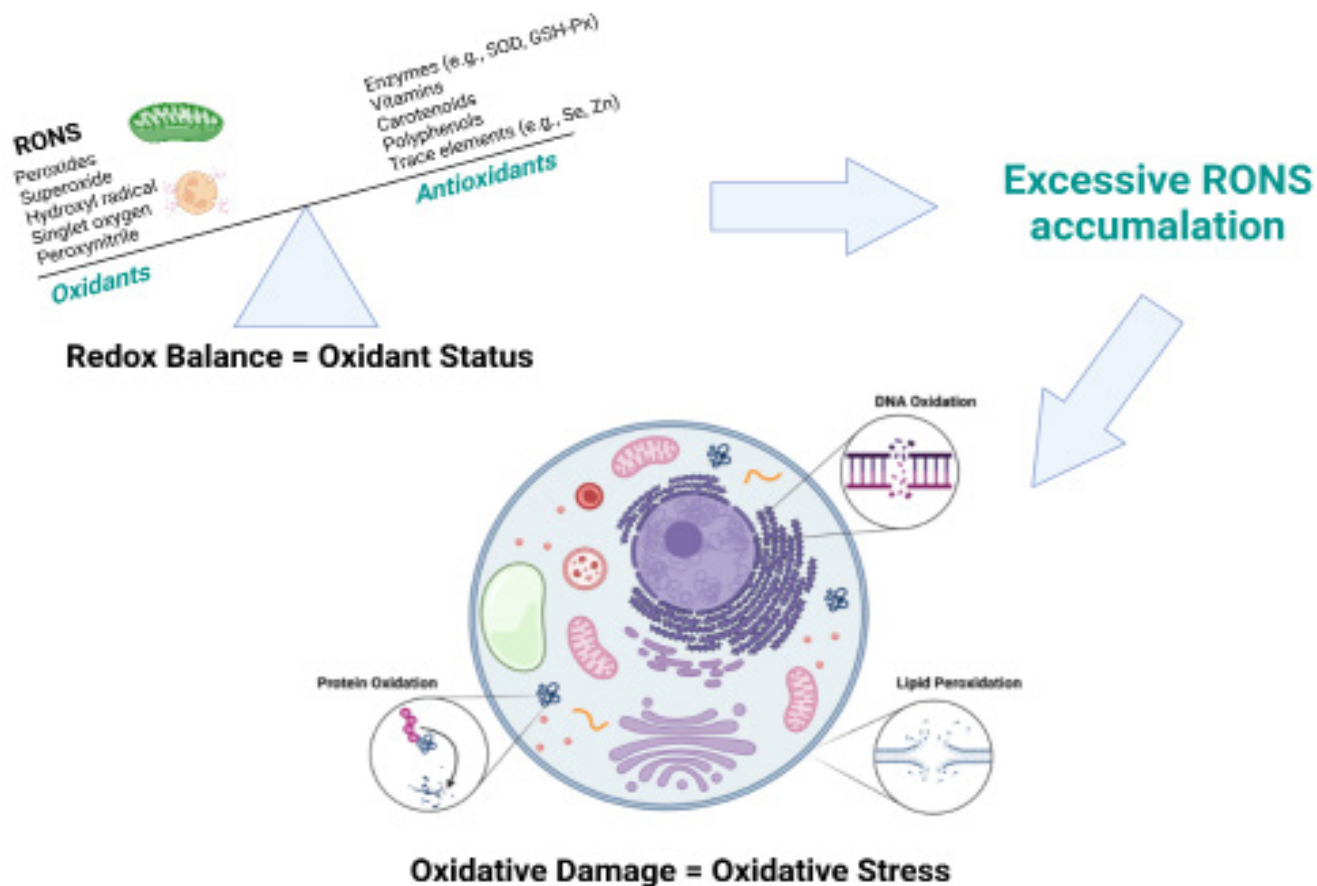


Figure 1: Graphical representation of the relationship between oxidant status and oxidative stress. When the production of reactive oxygen/nitrogen species (RONS) by cell metabolism (mitochondria) exceeds the neutralizing capacity of antioxidants, the accumulation of RONS can result in oxidative damage to cellular macromolecules such as DNA, lipids, or proteins. This oxidative damage is the hallmark of oxidative stress.

It is expected that oxidative damage occurs as a result of shifts in the oxidant balance. Nevertheless, not all shifts in redox balance will result in OS. RONS are essential for many physiological processes such as cell growth and proliferation. Therefore, changes in oxidant status might just reflect changes in redox signaling that are not associated with cell or tissue dysfunction.

This difference between OS and oxidant status also impacts the information that different biomarkers provide. In our group, we have validated the Oxidant Status index (OSi; calculated as the ratio between RONS and total antioxidant capacity) to characterize redox status in biological fluids, but measure oxidized macromolecules to evaluate OS. For example, we routinely quantify isoprostanes, a family of prostaglandin-like compounds formed through the oxidation of fatty acids in cellular membranes (Figure 2), and advanced oxidized protein products to evaluate the oxidative damage to cellular lipids and proteins, respectively.

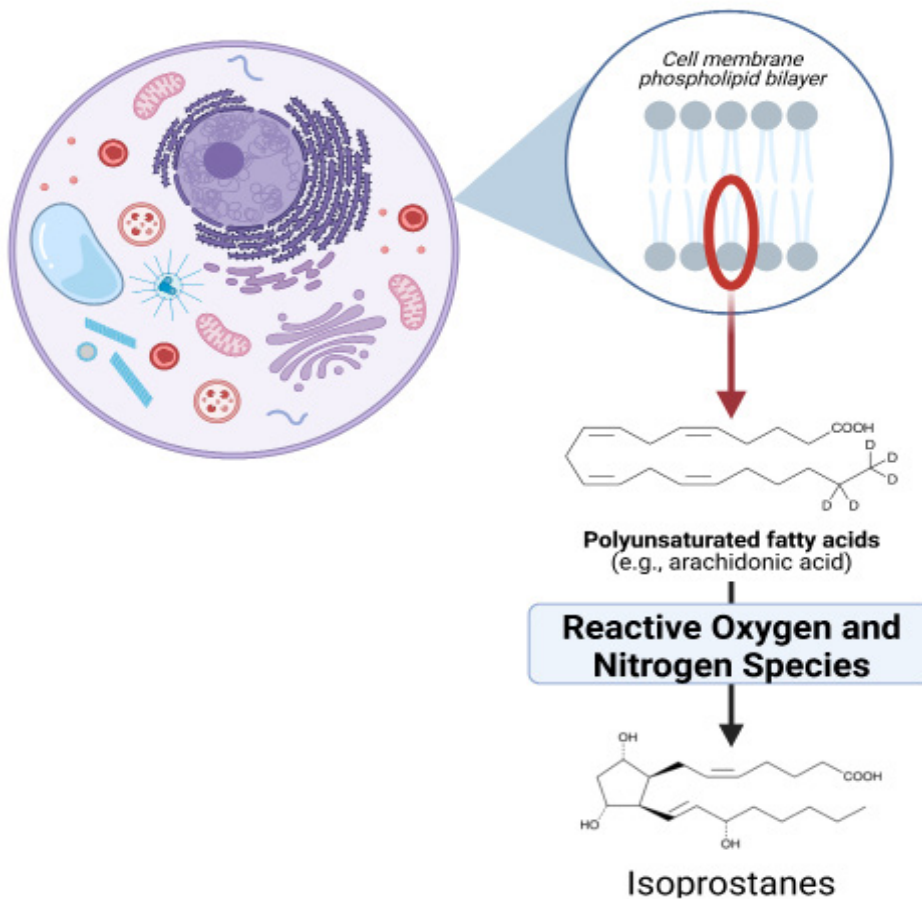
### Oxidative stress and transition health

Dairy cows go through dramatic physiological changes to prepare for lactation. In the transition cows, dry matter intake decreases, whereas energy demands for lactation increase, resulting in energy deficit. To meet the increased energy demands, cows release body reserves, predominantly from adipose tissue. Increased fat mobilization because of energy deficit increases the generation RONS. An increase in RONS production coupled with the decreased intake of dietary antioxidants due to decreased feed intake can lead to a pro-oxidant shift that ultimately results in OS. Oxidative stress is a significant factor underlying the dysfunctional host immune and inflammatory responses that can increase the susceptibility of transition cows to health disorders. OS is known to diminish the function of immune cells such as phagocytes or lymphocytes, and therefore increase the animals' susceptibility to infectious diseases. Also, RONS can activate inflammatory responses in cells such as macrophages or dendritic cells. Thus, OS is also involved in the dysregulated inflammatory responses typically seen in fresh cows.

Moreover, OS during the dry period can also have effects on the offspring. Our results showed that calves born to cows that underwent greater OS during late gestation showed less robust innate immune responses during the first month of life (Ling et al. DOI: 10.3168/jds.2017-14038). Similarly, we recently showed that the antioxidant capacity of cows during the last months of gestation might be a limiting factor in the volume of colostrum produced (Rossi et al., DOI: 10.3168/jds.2022-22240). Supplementation trials are currently underway to further evaluate these associations.

of oxidant status had a greater ability to predict fresh cow diseases at dry-off compared to common metabolic biomarkers such as non-esterified fatty acids (NEFA), beta-hydroxybutyrate (BHB), and calcium. Thus, including biomarkers of OS in herd monitoring protocols has the potential for allowing earlier detection of cows/cohorts at risk and to better inform nutritional management strategies such as antioxidant supplementation.

With a competitive grant from the USDA, our team is currently investigating the accuracy of markers of OS to predict cows at risk of developing fresh diseases early in the dry period. Current blood biomarkers used on



*Figure 2: Graphical representation of the generation of isoprostanes through the oxidation of cell membrane polyunsaturated fatty acids.*

**Biomarkers of oxidative stress for prediction of disease**

Biomarkers of OS and oxidant status have been proposed as potential predictors of transition cow disease. Nevertheless, neither reference intervals nor cut-off points for OS biomarkers have yet been established to identify individual cows suffering from OS or to predict the likelihood of disease events or impairment of production outcomes at the herd level. Therefore, the application of these biomarkers in the field is still limited.

Nevertheless, a recent study showed that biomarkers

for herd monitoring (e.g., NEFA or BHB) are only predictive of disease risk when analyzed during a few days around calving, precluding their use to implement corrective strategies to prevent early lactation diseases in the affected group. We aim to establish, for the first time, critical cut-off points for markers of OS in dairy cattle to allow for dry period monitoring protocols so that cows at risk of developing transition diseases can be identified with sufficient time to implement corrective measures.

Our preliminary data shows promising results. The concentration of one isoprostane was increased up

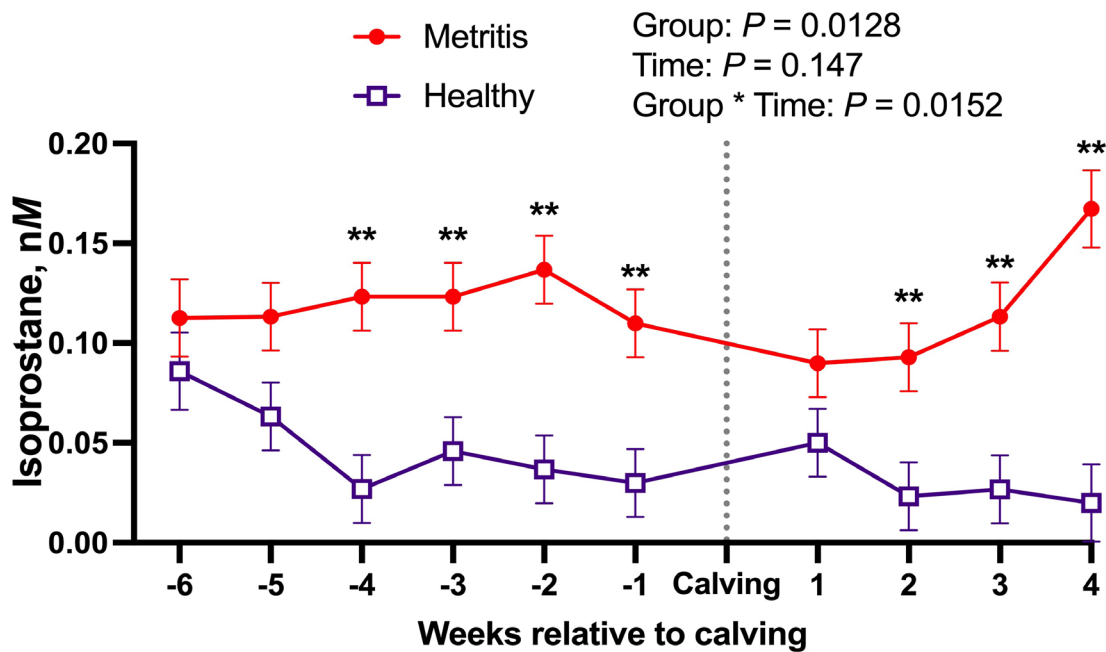


Figure 3: Plasma concentration (mean  $\pm$  standard error) of an isoprostane in cows that experienced metritis ( $n = 6$ ) and cows that did not experience any disorder (healthy;  $n = 6$ ) during early lactation. Multiparous cows from the same herd were blood sampled weekly from -6 to +4 weeks relative to calving. \*\*  $P < 0.01$ .

to 4 weeks before calving in cows that experienced metritis in early lactation compared to those that exhibited a healthy transition (Figure 3). As part of this project, we will also investigate which nutritional interventions could be implemented during the close-up phase to ameliorate OS in at-risk cows and avoid the development of fresh cow problems.

### Oxidant status and pre-weaning diseases

After birth, calves are exposed for the first time to an oxygen-rich environment when they start to breathe, resulting in an increase in RONS production. RONS concentrations in the blood of calves was 30% higher than in their dams shortly after birth and before colostrum ingestion. Our own results also suggest that calves experience a greater redox imbalance than periparturient cattle. Hence, OS might play a very significant role in neonatal calf health; indeed, OS has been associated with important calf diseases such as diarrhea and pneumonia.

Another critical factor to consider is the role of OS in the modulation of the immune response of newborn calves. In line with research in humans, the oxidant status experienced by newborn calves was associated with differences in their profile of cytokines (signals produced by immune cells). We further evaluated effects of in vitro OS on neonatal calf lymphocytes, the immune cells responsible for vaccination success. Our results showed that OS reduces the capacity of these immune cells to activate upon stimulation, to synthesize antibodies, and to release cytokines to communicate

with other immune cells (Cuervo et al., DOI: 10.3390/antiox10020255). These are all critical functions to fight a pathogen or respond to a vaccine. Thus, OS during the pre-weaning period is a contributing factor to the dysfunctional immune responses exhibited by young calves.

### Antioxidants and calf health

As for transition cows, several strategies exist to decrease the risk of OS in neonatal calves.

**Maternal supplementation:** In humans, maternal supplementation of antioxidant vitamins and minerals during gestation has long been recommended to reduce OS at delivery. Some studies in cattle have also shown that dry-period antioxidant supplementation enhances the antioxidant profile of newborn calves. Nevertheless, various factors limit this delivery route in cattle: (1) the nature of the ruminant placenta limits the types of antioxidants that can be transmitted to the fetus, (2) dry dairy cattle are usually already supplemented with considerable amounts of some antioxidants (e.g., selenium close to the US legal limit of 0.3 ppm) for the prevention of transition diseases, and (3) excessive antioxidant supplementation can have downstream effects in the health of dairy cattle and has been linked with stillbirths in humans. Hence, supplementation of dry cows to increase calves' antioxidant pool might not be an effective strategy.

**Supplementation of colostrum:** In addition to immunoglobulins, colostrum is also rich in other



beneficial substances such as immune cells, growth factors, cytokines, etc. Given that colostrum is the first meal that a calf should receive shortly after birth, its antioxidant content is important to offset the birth-associated OS. However, compared to normal milk, colostrum has the same amount of oxidants but less antioxidants, with the concentration of the latter increasing progressively from the first colostrum onwards. Hence, colostrum provides antioxidants to calves but is also a source of pro-oxidants. Nevertheless, newborn calves seem to be able to effectively counter the birth-associated OS, with calves showing a gradual decrease in oxidant status biomarkers. To the best of our knowledge, however, no study has compared the redox balance between calves that ingest colostrum shortly after birth with those experiencing delayed colostrum ingestion. Hence, it remains unexplored whether this gradual decline in OS following birth is due to the transfer of antioxidants via colostrum, the activation of antioxidative pathways in the calves, or a combination of both.

In addition, colostrum's redox balance seems to play a role in immunoglobulin absorption. Selenium supplementation of colostrum increases immunoglobulin absorption, and the colostrum redox profile was significantly associated with calves' serum immunoglobulin concentrations. However, none of these studies demonstrated which mechanisms might be implicated and therefore further research is needed. Some research at MSU has also investigated the impact

of supplementing colostrum with antioxidants and fatty acids. However, although the initial results showed a positive effect on calf redox status, those effects were not reflective of improvement on calf health.

**Supplementation of calves:** Other ways of increasing the antioxidant potential of calves are the parenteral or dietary administration of vitamins and trace elements. This is a routine management practice in many farms within the first days of life. It's been well-established that vitamin supplementation of dairy calves can increase their performance, metabolism, and immune system. Some studies have shown a reduction in pre-weaning disease incidence, which some attribute to the antioxidant's enhancement of immune function. Parenteral trace mineral supplementation (zinc, selenium, manganese, and copper) at 3 and 30 days of life resulted in increased the function of neutrophils (immune cells). Our team recently demonstrated that administration of parenteral antioxidant supplements simultaneously with an intranasal viral vaccine to newborn calves resulted in an increased response to the vaccine as assessed by antigen-specific immunoglobulin A antibody concentrations in nasal secretions throughout the first month of life (Figure 4; Nayak et al., DOI: 10.3390/antiox10121979).

### Cautions around antioxidant supplementation

Vitamins and certain trace minerals have proven effective at counteracting OS and the severity of diseases such as mastitis or metritis, both through direct antioxidant effects and by enhancing the immune response. Most

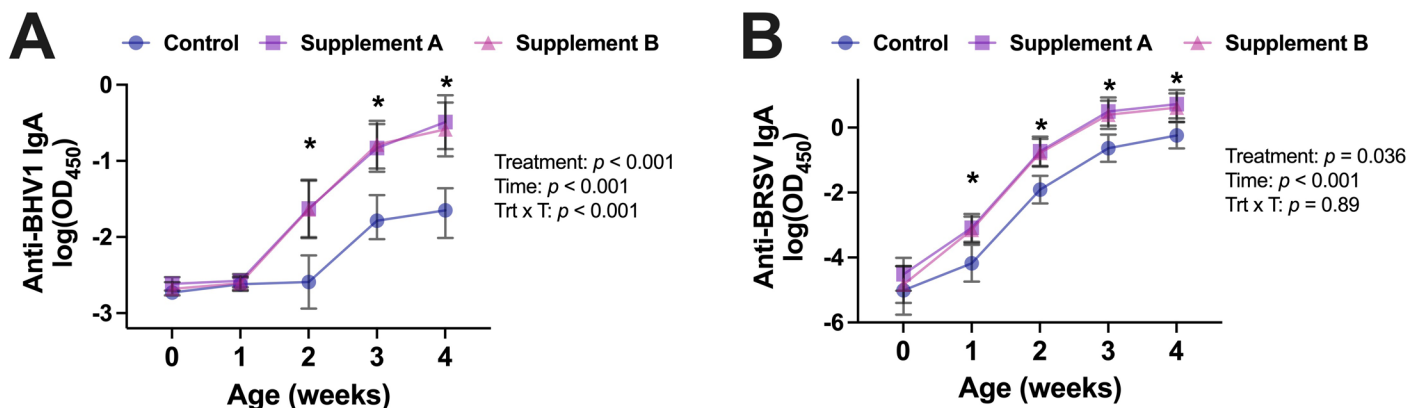


Figure 4: Immunoglobulin A antibody responses in nasal secretions throughout the first 4 weeks of age against (A) Bovine Herpesvirus-1 (BHV1) and (B) Bovine Respiratory Syncytial Virus (BRSV). Calves were randomly assigned at birth to one of two commercially available antioxidant micronutrient supplements or a placebo group receiving 0.9% sterile saline ( $n = 7/\text{group}$ ). Antigen-specific immunoglobulin A was measured to evaluate intranasal vaccine response. Results are presented as least squares means and 95% confidence intervals of the logarithm of the optical density at 450nm (OD<sub>450</sub>). OD<sub>450</sub> readings are proportional to the amount of immunoglobulin A in the sample. \*Denotes differences ( $P < 0.05$ ) between the control and the supplement groups at a given age.

of the established nutritional requirements traditionally focus on preventing deficiency situations and these requirements are different than those for optimal immune function. Indeed, there is now evidence that supplementation slightly above reported requirements can improve animal health status and performance, as well as milk and meat quality.

On the other hand, some studies reported negative effects of excessive antioxidant supplementation, such as increased cases of mastitis or even toxicosis in calves. To date, it has been unclear at what level antioxidant supplementation stops being beneficial and starts to be associated with harmful consequences. Hence, antioxidant supplementation strategies must be implemented only to levels slightly above current recommendations unless strong scientific evidence is available to support its inclusion at a higher rate. Our team is currently undertaking a field trial to investigate the dynamics of antioxidants supplemented to calves to provide evidence-based recommendations to producers.

#### **SUMMARY**

Redox balance is essential for several biological processes of dairy cows and calves. However, when an imbalance exists between the production of pro-oxidants and the animals' antioxidant abilities, OS can develop, and this has been associated with immune and metabolic dysfunction. However, antioxidant therapy can protect against OS conditions, and several methods for delivery of antioxidants are routinely used in dairy farms. Antioxidant supplementation levels for optimized immune function are usually above the nutritional requirements established through traditional methods. However, excessive antioxidant supplementation can negatively impact animal health. Thus, a better understanding of the regulation of antioxidant networks and the establishment of critical cut-offs for concentration of OS biomarkers are needed to be able to provide evidence-based guidance on levels and timing of supplementation that provide an effective improvement of the animals' health status.

#### **ACKNOWLEDGEMENTS**

This work has been supported by competitive grants no. 2018-67015-28302 and 2022-67015-36350 from the USDA National Institute of Food and Agriculture, by the Michigan Alliance for Animal Agriculture, and by the Michigan Animal Health Foundation. The authors wish to acknowledge the many contributions of the late Prof. Lorraine M. Sordillo to the field of redox biology in cattle.

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MSU Extension and Director  
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# Michigan Dairy Recognition

Shining a light on industry leaders



## **Katelyn Packard named 2022 MMPA Outstanding Young Dairy Cooperator**

Katelyn Packard of Manchester, Michigan, was selected as the state winning 2022 Michigan Milk Producers Association (MMPA) Outstanding Young Dairy Cooperator (OYDC) by a panel of leaders in the Great Lakes dairy industry. As the state winning cooperator, Packard will represent MMPA at various industry and association activities.

Packard farms 950 acres and operates a 450-cow dairy with her family. She is a member of the MMPA Saline-Ann Arbor Local in District 1 and also serves as an MMPA Dairy Communicator, working to promote dairy in her local community. Packard and her family regularly invite neighbors to tour their farm and run a successful farm store where they sell products from their farm. “We strive for happy, healthy, well-fed animals and have found when this happens, everything else falls into place,” Packard said. “Our farm’s mission is to provide healthy and safe food while caring for our animals, the environment, and our community.”

[View full article here](#)



## **Tjerk and Ramona Okkema inducted into the Michigan Farmers Hall of Fame**

Tjerk and Ramona Okkema of Blanchard were inducted into the Michigan Farmers Hall of Fame on September 10. The couple has been involved in agriculture for over 40 years; Tjerk was raised on his family’s dairy farm in the Netherlands and Ramona grew up on a diversified dairy in New Hampshire, overseeing her family’s greenhouse and roadside stand. They began their farm in Michigan in 1999, De Grins Oer Dairy (Over the Border Dairy). The Okkemas currently milk 700 cows, shipping over 2 million pounds of milk per month, and also farm 1,620 acres to feed their cattle and sheep. The dairy has been recognized with numerous state and national awards for milk quality, and Ramona received the Excellence in Dairy Promotion Award at the 2019 Great Lakes Regional Dairy Conference.

The Michigan Farmers Hall of Fame began in 1982 as a way to honor the hard work and contributions of farm couples from across the state. The Hall of Fame now resides in the Belcher Building at the Calhoun County Fairgrounds in Marshall.



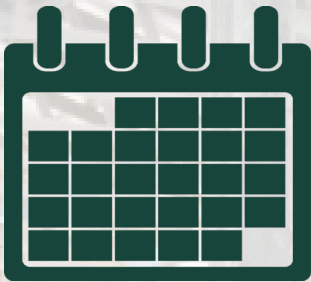
## **Carla McLachlan: behind the scenes at the Michigan Dairy Expo**

Carla McLachlan has been instrumental in the success of Michigan 4-H Youth Dairy Days and Michigan Dairy Expo for more than 25 years. She’s seen the event change since having cattle shows at Farm Shop, the move from the Livestock Pavilion on main campus to the MSU Pavilion on south campus, and growth from just cattle shows to educational events for youth and a celebration of the Michigan Dairy Industry. Over this time, hundreds of youth have demonstrated their cattle and life skills, with McLachlan offering support to both young people participating and staff working during the event. She has been a stable, guiding force as faculty leadership, location, and participation changed. The Department of Animal Science, Michigan 4-H, and the Michigan Dairy Industry are grateful for McLachlan’s years of dedicated service.

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## Mark your calendar

Want to connect with  
your local dairy  
extension educator?  
Find them here:



- [MMPA Cover Crop Field Day](#)  
Westphalia, MI - October 18, 2022
- **Revenue from Manure program**  
Fair Oaks, IN - November 8, 2022
- **Nutrient Management Workshop**  
St. Johns, MI - November 10, 2022
- [Raising and Managing Cows for Automatic Milking Systems](#)  
Webinar - November 16, 2022
- [Thumb Ag Day](#)  
Ubly, MI - December 14, 2022
- [Great Lakes Regional Dairy Conference](#)  
Mount Pleasant, MI - February 2-3, 2023