



Ag Innovation News

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DETERMINED TO INNOVATE

For AURI's 2020 Ag Innovator of the Year, 29 was the magic number.
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AURI: Working with Underserved Communities Throughout the State

BY SHANNON SCHLECHT
AURI EXECUTIVE DIRECTOR

AURI has never had a traditional story; created by the Minnesota Legislature to support the state's agricultural producers, processors and rural communities by developing new, value-added products and processes. Even our client list isn't what you might consider "traditional" with regards to the term agriculture. Typically, when one hears "agriculture" they immediately have a picture of what traditional agriculture is in Minnesota. However, AURI's model of innovation and its reach was never meant to conform to tradition, but to supplement it.

In addition to helping bridge the gap between agriculture, innovation and entrepreneurship, AURI always places a high value on working with underserved and ethnic communities throughout the state. Over the years, AURI has been a proud partner of both traditional and diverse communities of color, including first nations tribes, minority owned businesses and underserved communities.

I believe this reflects AURI's belief that Minnesota's agricultural ecosystem is truly broad and varied. AURI's statewide approach equates to a commitment to support all communities. In doing so, we believe Minnesota is a stronger, more economically robust and more innovative place.

In recent years, AURI has partnered with groups, like the Hmong American Farmers Association to help develop its work in value-added agriculture and use of commodity byproducts. We have also worked with the Red Lake Nation and their Gitigaanke local foods initiative which envisions individuals, families and communities being empowered to revitalize a sovereign and traditional food system that provides healthy and affordable foods in a sustainable manner.

While these are both examples of projects AURI has undertaken with large groups, I am also very proud of the organization's work with dozens of individual clients within our immigrant communities who are striving to bring cultural products from their homeland to fellow expatriates and new consumers in Minnesota and across the United States. We have also collaborated on research initiatives to raise awareness around market opportunities in Minnesota related to Halal and Kosher meat products.

It should come as no surprise that this work is heavily focused on the food industry, as food is one of the most common ways to identify and celebrate a culture. Some examples I'm really excited about include projects developing African sauces, stews and beverages, as well as new uses for chickpeas and traditional Asian cuisines.

These are all important projects because they add to the vibrant tapestry of Minnesota's rural and urban communities. From Angle Township in the north to Peterson in the south, these are projects that can bring Minnesotans together to foster a better understanding of diverse cultures and their contributions to agriculture and Minnesota.

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In Celebration of

Larry Lee Johnson

BY AURI

The Agricultural Utilization Research Institute (AURI) was saddened by the passing of its Board Secretary Larry Lee Johnson on July 19, 2020. While the time since his passing has been one of grief for AURI, we wish to share this memorial with you, the valued Ag Innovation News reader.

Larry was a committed board member and advocate for the AURI and Minnesota's agricultural community. He began his volunteer service with AURI in January 2017 and had just started his second three-year term in 2020. Larry's contributions to Minnesota's value-added agriculture extended for decades beyond his service for AURI. The positive impact Larry had on his fellow directors, AURI staff and the industry will be long-lasting.

Larry had an exceptional life grounded in his deep roots within Minnesota's agricultural community. Born in St. Peter, Minnesota in 1944, Larry was a life-long resident of San Francisco Township where he ran a cash grain farm and turkey hatching egg operation for three decades.

Many of us at AURI remember Larry for his persistent curiosity, larger-than-life presence and iconic mustache. He was known for always being ready with a question no matter the topic or AURI project. Larry became involved in many facets of the organization, from providing guidance on new technology development and acting as a public face of the organization to engaging with staff on their project work and check-in calls. He was committed to his board responsibilities and was always quick to volunteer his time and support to new initiatives.

He was a positive influence on new board members who said he made them feel welcomed and comfortable in their first meetings to the board, calling him an instant friend. His curiosity was a notable value as he was not afraid to ask any question (what, why and how) during meetings, which contributed to a positive environment for others to jump into discussions and ask questions or engage with insight. That humbleness of showing he did not have all the answers but knew how to ask the right question was an admired trait. The combination of those characteristics will be one of the most missed elements to AURI.

To those outside of AURI, Larry was often known as the "Ethanol Answer Man" for his efforts in correcting the many misperceptions about the use of ethanol blends in a variety of engines. Larry provided consulting services to many facets of the U.S. ethanol industry as well as policy support for fuel ethanol interests. He was one of the founders of the public/private partnership in Minnesota that has come to be known as the "Minnesota Ethanol Model."



Larry was active in the Minnesota Corn Growers Association, serving as President in 1985. He also served on many other boards and task forces including the National Corn Growers Board and the Metro Association of SWCDs. He was elected as supervisor to the Carver Soil and Water Conservation District from 1978 to 1990.

It was Larry's curiosity and personal approach that made the biggest impression on people. He had a special way of interacting with AURI team members that made them feel valued and heard. According to AURI Board Chair Ron Obermoller, "Larry never quit trying to improve his world, whether it was helping strangers or advancing research to build rural Minnesota. While we will eventually fill Larry's seat on the Board, we will never be able to replace him."

Larry took his commitments seriously, while also being serious about making it fun in the process. He was consistent in his approach and those that met him often cited his good-natured personality, openness and approachable demeanor.

To summarize Larry's mark on AURI, the following were all mentioned by board directors and staff: larger-than-life, curious, open, warm, enthusiastic, engaged, personable, impressionable, authentic, respectful, genuine, kind, caring, approachable, dedicated, knowledgeable, good-natured, appreciated, humble, intellectual, welcoming and wonderful.

Larry is survived by his loving family and will be remembered by multiple generations of Johnsons.

His impact and contributions to AURI and the state's agricultural economy is cause for celebration and remembrance for years to come.

BIG CHALLENGES

and **BRIGHT INNOVATION**

AT THIS YEAR'S BOLD OPEN



BY AURI

Events and large group gatherings across the country have been canceled due to COVID-19, resulting in a general slowdown in innovation and new product development discussions. However, a group of innovative Midwest-based companies created a new way to further innovation throughout the United States and around the globe by hosting a virtual open innovation platform and online reverse pitch event, called The Bold Open.

This virtual event, held at the end of July, brought together leading Minnesota food and agriculture companies and research entities to highlight unique industry challenges with the goal of creating partnerships with producers, entrepreneurs, researchers, businesses and creators that have innovative solutions.

While reverse pitch events are becoming more common, what sets the Bold Open apart is its strong connection to food and agriculture. This is an important distinction for these times when producers face low commodity prices and businesses face industry challenges related to sustainability and use of waste streams. So, it should come as no surprise that nearly half of this year's challenges focused on these issues.

Overall, there were 20 challenges presented at this year's Bold Open. Each one focused on different areas of the food and ag industry based on the collaborator's specific innovation needs. Highlighted below are a few examples of the 2020 Bold Open challenges. To check out all of the collaborators and challenges, visit boldopenmn.com.



Treatment of Perfluoroalkyl Substances

Ecolab presented a challenge entitled "Treatment of Perfluoroalkyl Substances (PFAS)" which looks to identify treatment solutions that can significantly reduce the amount of Perfluoroalkyl substances (PFAS) in water entering food and beverage manufacturing facilities.

Despite PFAS production being phased-out in many countries, its persistence in the environment will result in these compounds continuing to be a concern for many years to come. Water is often used within the food and beverage industry as an ingredient, so ensuring this water is PFAS-free is an important food safety consideration.

Ecolab's challenge focused on finding solutions that are applicable to treatment of the water at the food and beverage manufacturing site and could be used to either treat all the water entering the site or just

the water used as an ingredient. At the same time, solutions need to consider the impact of water quality on the food and beverage producer's product quality.



Fresh Meat Shelf Life

Cargill presented the challenge, "Fresh Meat Shelf Life," which looks for innovative solutions that extend shelf life of refrigerated meat and egg products, while maintaining the company's commitments to sustainability, quality, optimal nutrition and food safety.

The reason Cargill is seeking an answer to this challenge is because reducing food waste is a priority for the company, and a critical part of its BeefUp initiative, which aims to reduce greenhouse gas emissions in the U.S. beef supply chain by 30% by 2030.

As a growing global population demands more protein, this is part of Cargill's strategy to ensure efficiency in the supply chain from farm to fork.



The Future of Distillers' Grains

Another value-added challenge, presented by Glacial Grain Spirits (GGS) at this year's Bold Open, addressed the "Optimization of Organic Feed Usage."

GGS wants to identify efficient, effective handling and marketing solutions to add value to small batch organic distillers' grains from corn. Because GGS produces a high-quality organic ethyl alcohol used in many applications from cosmetics and pharmaceuticals to beverages, it also produces about 385 tons of organic distillers grain every year. Currently GGS has limited opportunity to utilize this valuable feedstock as existing storage space and drying capacity do not allow the facility to segregate

these distillers' grains to maintain both food grade and organic certification.



Incorporating Regionally Appropriate Small Grains

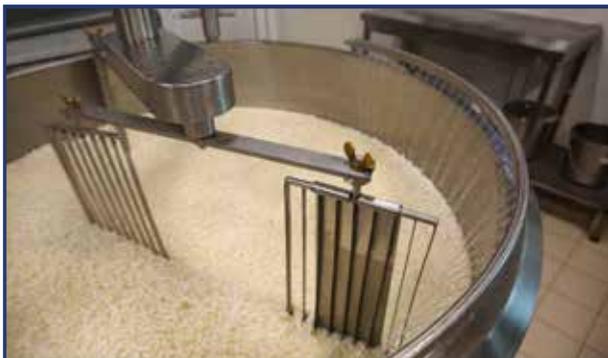
Next, Hormel Foods presented a challenge for "Cropping Innovations for Beef, Poultry and Swine Feed."

It sought insight and partnership strategies to expand incorporation of regionally appropriate small grains such as oats and cover crops in corn/soy production systems with the aim of reducing the greenhouse gas (GHG) footprint and improving the water stewardship of crops used in beef, turkey, chicken and swine feed.

Hormel Foods' reason for seeking innovation in this space was a desire to reduce its Scope 3 GHG emissions and improve water stewardship in its supply chains. The development and adoption of beef, poultry and swine feed that incorporates small grains and cover crops in production systems will be rooted in innovation by animal producers who grow their own feed, grain growers that supply feed or ingredients for commercial sale, and stakeholders in the supply chain to bring such feed to market. Hormel Foods believes input from farm-based organizations, agronomists, animal nutritionists, environmental scientists, grain handlers and crop commercialization strategists will help illuminate new pathways and innovations toward feed production that incorporate small grains or cover crops.

At the same time, Hormel Foods and Jennie-O also presented a joint challenge for "Nutrient Separation and Re-usable Poultry Bedding," to develop environmentally sustainable solution for poultry litter.

As leaders in food technologies in agriculture, this is a priority for Hormel Foods and Jennie-O because they are interested in advancing environmentally sustainable initiatives on the farm. They believe poultry byproducts need additional innovation for sustainability.



Uses for Dairy Product Solids

During the Bold Open, Land O' Lakes Inc. presented a challenge seeking "Novel Uses for Milk and Whey Permeate." More specifically, they are seeking to identify novel industrial uses for milk permeate or whey permeate in liquid or dry form. Both Milk and

Whey Permeates may also be known as dairy product solids.

Land O'Lakes is interested in this because of the high quantity of industrial uses for dry or liquid milk and/or whey permeate. The company desires to increase the value of dairy by-products for its farmer owners by identifying new uses. Both food and non-food uses will be considered but non-food uses are a key area of interest.



More Uses for Plastic Packaging

MBOLD, a coalition of Minnesota's globally leading businesses, researchers, and food and agriculture producers, presented a challenge to identify "End Uses for Recycled Flexible Plastic Packaging." To that end, MBOLD is seeking partners in the recycling, re-processing and manufacturing sectors in reasonable proximity to Minnesota to jointly explore market-based collaborations aimed at fostering a more circular economy for flexible films.

The organization was seeking partnerships because the use of flexible plastic packaging, a broad category including plastic pouches, wraps and bags, is expanding rapidly. Plastic film and flexible packaging in North America is projected to grow 3% annually with current US demand at approximately 12 billion pounds (valued at \$24-25 billion) per year. This packaging material is designed to deliver food safely and efficiently. From a life cycle analysis, flexible films are almost always the best choice. Flexible films are also used in many other aspects of the food and agricultural system. However, only 4% of this material is recycled, with nearly all of it ending up in landfills at end of life.



A Lot of Soybean Hulls

Another value-added challenge presented at this year's Bold Open event, which came from the Minnesota Soybean Research and Promotion Council (MSRPC), addressed the need for "New Uses for Soybean Hulls." The MSRPC believes soybean hulls represent an opportunity to better utilize the various components to create higher value products by further processing them using extraction technologies or microbial or bacterial processes.

According to the MSRPC, soybean hulls—the outer coating of a soybean seed—represents about 7-8% of a whole soybean seed. That soybean hull must be removed at the first point of processing to efficiently extract soybean protein (meal) and soybean oil. The biggest end use market for soybean hulls currently is ruminant feed. Current industrial uses for soybean hulls include bioremediation and as a filler for biobased plastics.



Small Farmer Financial Resource Tools

Finally, Compeer Financial presented the challenge "Small Farmer Financial Resource Tools" which sought to find efficient methods to serve small and micro farms so that the farmers can concentrate on producing quality products and get the products to market in a timely fashion.

Smaller farms may require more labor and use less machinery to complete the work in a timely fashion and maintain quality products. As a result, the farmers still have the financial needs to operate their farm but may not have the time to spend on their financial tools. Compeer is looking to work with more of these operations to be a resource, trusted advisor and partner. Potential solutions could include mobile applications, new software, online services, marketing plans and marketing opportunities.

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BOLD OPEN

DETERMINED

BY DAN LEMKE
PHOTOS BY ROLF HAGBERG

Innovations rarely succeed in their first iteration. In most cases, success takes time, effort and more than a few failed attempts. For AURI's 2020 Ag Innovator of the Year, 29 was the magic number.

Milk Specialties Global is an Eden Prairie-based dairy processing company that develops high-quality nutritional ingredients for livestock producers, as well as milk and whey protein ingredients for human nutrition and functional foods. The company is one of the largest whey protein processors in North America.

Milk Specialties Global enlisted AURI's help in developing coated pellets to deliver bypass amino acids to dairy cows.

"Bypass means the supplement is protected through the four chambers of the cow's stomach so that it can get to the small intestine where it can be broken down and utilized by the animal," says AURI Senior Scientist for Coproducts Alan Doering.

Doering says lysine and methionine are two of the most limiting amino acids in most dairy diets. Raising lysine and methionine levels increases dairy cow performance and milk production. Because cows cannot synthesize lysine or methionine on their own, those nutrients have to be delivered through diet.

"Lysine and methionine are needed to properly balance dairy diets, especially for those animals that are fed a corn-based diet," says Chuck Soderholm, Milk Specialties Global Director of Research and Nutrition. "Lysine helps with milk yield and milk components; methionine improves milk components such as protein and fat."

From Idea to Market

Developing the coated products took time and a few setbacks. Milk Specialties Global worked with AURI because the coproduct utilization lab in Waseca has the tools necessary to do small test formulations and evaluations. Doering and AURI Associate Coproduct Scientist Abel Tekesté assisted with initial product development research and narrowed down many of the production parameters needed to make pellets that could be coated and fed to cattle.

"We had our hurdles," Doering says, and Soderholm agrees.

"It was rough sledding. It took 29 tries to get the right formulation for lysine," Soderholm says. "There's no way we could have done that on our own."

After multiple attempts, the researchers were able to develop a pellet with the right density and durability. Milk Specialties Global had the recipe to deliver coated lysine and coated methionine.

"We have a tremendous pan coating," says Milk Specialties Global CEO Dave Lenzmeier. "But it can be a challenge to get nutrients through the rumen so cattle can fully utilize them."

"With coated products, you have to have a solid inner core. It's like an M&M," Soderholm contends. "The coating is good, but you also have to have a good piece of chocolate in the middle."

Once the pellet formulation was identified, Milk Specialties Global did further research on the encapsulation to improve and evaluate bypass

efficiency at their own facilities. In 2018, the company introduced two new products to the marketplace.

EB-MET™ by Energy Booster® is a rumen-protected methionine supplement. Methionine plays a key role in many biological functions during transition, breeding and lactation. Milk Specialties Global also produces and markets EB-LYS™ by Energy Booster®, a rumen-protected lysine supplement.

Lenzmeier says the coated ingredients provide a dual benefit by delivering both bypass amino acids and energy from the rumen inert fatty acid coating.

"The most limiting ingredient for a dairy cow is actually energy," Lenzmeier says. "More energy, more milk."

Soderholm estimates 25 percent of U.S. dairy cattle are getting methionine supplements and about 15 percent get lysine. The potential market for Milk Specialties Global's products is huge.

Collaboration

Working with AURI helped Milk Specialties Global develop their concept and turn it into a product that is now widely available to livestock producers.

"The great thing about AURI is they were a catalyst to provide technical support and equipment to take an idea beyond pilot stage. Now we're shipping truckloads," Lenzmeier explains. "This is a great example of collaboration that has a meaningful impact on us and on other companies. We're now selling millions of pounds of product and we're just getting started."

Doering says other companies are working in the bypass amino acid arena, but Milk Specialties Global has an advantage because they use byproducts such as milk fat from their own dairy processing.

"Milk Specialties Global generates a lot of the required ingredients for improved performance from within their own process," Doering says.

"We offer a good value proposition for customers," Soderholm says. "They can get protected amino acids at a slightly lower cost and get the energy for free."

Innovation Recognized

The innovative use of a dairy processing coproduct leading to commercial success is why Milk Specialties Global was selected by AURI as their Ag Innovator of the Year. Since 2002, AURI has presented the award to highlight and celebrate an AURI client that exhibits innovation and has achieved success in the marketplace.

"AURI sees some amazing innovations across the state each year and it often happens under the radar of media and industry," says AURI Executive Director Shannon Schlecht. "The Ag Innovator of the Year award provides a platform to recognize innovative applications that may go unnoticed by others and hopefully inspires others to continue their commercialization journey of industry-changing technologies."



Doering says that transforming an idea into a marketable product can be an arduous process. However, seeing a client achieve success because of AURI assistance while adding value to a Minnesota ag product is gratifying because it fulfills AURI's mission.

"This was a very enjoyable project. It was fun to see how it moved from idea to reality, from the concept stage all the way to being available to the dairy producer," Doering says. "Milk Specialties Global is an excellent recipient for the Ag Innovator of the Year. They're very innovative in identifying new opportunities. Their processing generates coproducts, and they're an innovative group that looks for ways to utilize these products for feedstuffs or as a higher value product."

"As an organization, it is fun to celebrate a successful collaborative effort," Soderholm says. "There were a lot of smart heads involved with this project. It means a lot to have an award from AURI because they are well thought of, and we owe AURI a lot."

While the coated lysine and methionine pellets have reached the market, AURI continues to work with Milk Specialties Global on other projects intended to move agricultural products into new places. The level of success clients like Milk Specialties Global achieves reflects well on AURI's abilities to collaborate with innovators.

"I think it shows that AURI has certain skill sets that can help businesses of multiple sizes, from early stage

TO INNOVATE

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YEAR



in California, Wisconsin, Illinois and Mountain Lake, Minnesota. The company also expanded their product offering and business scope.

Today Milk Specialties Global is comprised of three business units, with corporate headquarters in Eden Prairie, Minnesota.

Milk Specialties Global Animal Nutrition offers a range of specialty dairy ingredients used in the formulation and processing of animal feeds, as well as a comprehensive line of milk replacers, ration supplements and rumen-inert fats.

Lenzmeier says Milk Specialties Global enjoys a mutually beneficial relationship with the nation's dairy farmers. The company purchases about 16 billion pounds of milk equivalent or about 9 percent of the nation's milk supply each year. Coproducts from their dairy processing are used as nutritional ingredients designed to help those same dairy farmers become more efficient and productive.

"We are a substantial buyer of milk, so our relationship with dairy producers is different. We buy from them and look out for their best interest," Lenzmeier explains. "We want to bring the best technology to them for their success. We have a symbiotic relationship."

Milk Specialties Global worked with AURI to develop coated bypass protein ingredients to deliver needed amino acids lysine and methionine to dairy animals. Lysine and methionine can only be delivered to animals through diet and they are important nutritional ingredients for increased milk production.

"Dairy farmers are being paid for the dry components in the milk, protein, fat and lactose," says Milk Specialties Global Director of Research and Nutrition Chuck Soderholm. "Anything we can do to help protein and fat go up helps with their profits."

"We are both a customer of the dairy industry and a manufacturer of products for dairy producers," Lenzmeier adds. "We look at our partnership with the industry as very important. We want them to be successful."

In addition to offering their own branded products, Milk Specialties Global provides ingredients to feed and animal nutrition manufacturers nationwide. Products are available for dairy cows and calves, pigs, horses, goats and even companion animals like dogs and cats.

Milk Specialties International Group exports basic and high-performance nutritional ingredients to a number of international markets, including Asia where there is growing demand for dairy proteins and carbohydrates. The group operates out of the Milk Specialties corporate headquarters in Eden Prairie, Minnesota.

In recent years, Milk Specialties Global has turned more attention to human nutrition. Milk Specialties Global Human Nutrition is a customized protein ingredient provider that serves the rapidly growing sports nutrition and weight loss segments of the food and beverage industry. The group offers a broad portfolio of value-added whey proteins, milk proteins, hydrolysates and specialty proteins.

"We started a little flat-footed on human nutrition," Lenzmeier acknowledges, "now we make over 100

types of whey protein and we can adapt to whatever our customers want. It may be more difficult to produce, but we make a conscious effort to meet the needs of our customers."

Although they have not branded products for the human nutrition market, Soderholm estimates about 60 percent of their production is for human consumption, including snack bars and protein drinks.

"Dairy products are readily digestible, high-quality protein sources," Soderholm says.

Having a presence in both the animal and human nutrition world means Milk Specialties Global can efficiently process all of ingredients they acquire. Lenzmeier says the company leverages 100 percent of in-bound materials into marketable ingredients.

Innovation Driven

Entering into new and ever-expanding markets is indicative of Milk Specialties Global's commitment to innovation.

"Innovation has been the backbone of our evolution," Lenzmeier says. "Since we started, we've developed alternative formulations to match what our customers need."

"We're always innovating," Soderholm agrees. "What can we do that's new, what can we do better?"

AURI recognized Milk Specialties Global's commitment to innovation by naming them 2020 Ag Innovator of the Year.

"Their efforts to advance animal nutrition and human nutrition has been unwavering and there is a clear passion to always explore new ways to do things better," says Shannon Schlecht, AURI Executive Director. "They not only continue to innovate, but they are also clearly meeting industry expectations and needs with their growing business."

To learn more about Milk Specialties Global, visit www.milkspecialties.com.

entrepreneurs that may be pre-revenue to working with existing businesses around new innovation areas they want to explore and add to their product portfolio," Schlecht adds. "AURI is proud to work with companies like Milk Specialties Global that are constantly pushing agricultural innovation forward to see what is possible through science and technology."

Learn more about the Ag Innovator of the Year and read about past winners by visiting: <https://www.auri.org/news/ag-innovator-of-the-year/>.

Powered By Dairy

Milk Specialties Global is one of the nation's leading dairy processors and one of the industry's most innovative companies, serving both animal nutrition and human nutrition markets. Milk Specialties Global began operating in the 1940s, producing one primary product.

"The company focused for several decades on producing animal milk replacer, an Energy Booster® supplement for lactating dairy cows. That was really the flywheel of the business," says Milk Specialties Global CEO Dave Lenzmeier. "It put us on strong financial footing."

Lenzmeier says the company bought additional whey processing plants in 2008. Milk Specialties Global went from three processing plants to 10 facilities scattered across North America, including plants





ONE STEP CLOSER

BIOREACTOR RESEARCH IMPROVES PROCESS, SHORTENS TIME

BY DAN LEMKE

Water quality and nutrient management can be vexing issues for farmers. Growers need fertilizer to achieve maximum crop yields, but they must also manage those nutrients to reduce potential run-off, which causes negative impacts on water quality.

Studies have linked nitrogen losses in the form of nitrates from tile-drained row cropland to ecological challenges in the Gulf of Mexico. Nitrates dissolve in water, so farm-applied fertilizer intended for crops can escape when there's too much water.

"The biophysics of the system is that soil particles have a negative charge that holds cations really nicely," says Gary Feyereisen, agricultural engineer with the USDA Agricultural Research Service in St. Paul. "For example, potassium is held in the soil for the plant to use, ammonium too, but nitrate is a negative ion, so it doesn't stick to the soil. It goes wherever the water goes. It is very challenging to raise crops at the productivity level that we are and not have some nitrate leak out of the system when there's too much water."

AURI-supported research with the USDA-Agricultural Research Services, the University of Minnesota (UMN) Water Resource Center and the UMN Southwest Research and Outreach Center (SWROC) is helping shed more light on one practice designed to reduce the level of nitrates leaving farm fields and escaping into surface water while potentially offering a value-added opportunity for agricultural biomass.

Denitrifying bioreactors are typically horizontal in-ground structures put on the edge of a field or on the bank of a drainage ditch so water is treated before it exits into the ditch. Drainage water flows through the bioreactor filled with a carbon source like wood or agricultural biomass. Microbes live on the biomass and convert nitrates in the water to harmless nitrogen gas. The nitrogen gas releases into the atmosphere and the treated drainage water flows on to ditches, creeks or nearby wetlands.

Still Refining

Bioreactors have proven to reduce nitrates in drainage water, but researchers are learning more about how to speed the bioreaction process. A shorter water residence time in the bioreactor could also reduce the bioreactor footprint and increase the economic attractiveness to farmers.

Nearly a decade ago, AURI scientists worked with Feyereisen to evaluate the potential of various agricultural residues and coproducts suitable for bioreactor media. Wood chips are typically used but they can be expensive and not readily available. Researchers tested an array of ag residues including barley straw, corn stover and corn cobs to compare how effective they were at hosting the microbes.

"Some previous AURI research looked at various ag products. We found that corn cobs performed as well or better than the wood chips that are typically used," says Alan Doering, AURI senior scientist for coproducts.

Since the initial evaluation, Feyereisen has continued to test and refine the bioreaction process through benchtop research. Working with layers of wood chips and corn cobs, Feyereisen also began adding supplemental carbon to improve the reaction time.

"We started to add an additional dissolved carbon source to speed the flow. If we can speed up the flow through a given amount of space, the bioreactor footprint will be smaller and the cost will be lower," Feyereisen says.

Feyereisen added acetate as an additional carbon source for the resident microbes to go along with the corn cobs and wood chips already in the bioreactor. One of the goals of the research was to see if a shorter hydraulic residence time was achievable within the bioreactors while still removing the nitrate without increasing greenhouse gases.

Most bioreactors allow drainage water to spend about eight hours in the system before it flows out. Feyereisen wanted to learn if that hydraulic residence time is reduceable to two hours or less through a combination of added carbon and a vertically oriented reaction chamber.

Results showed the nitrate removal rate for the treatment with additional carbon and a two-hour hydraulic residence time was more than 2.5 times that of the treatment without the added carbon, even after spending 12 hours in the baseline bioreactor.

Feyereisen found the positive treatment results encouraging, but he was also pleased to discover what did not happen.

"Once nitrogen is in nitrate form, a certain amount will go to nitrous oxide, which is a greenhouse gas," Feyereisen explains. "Usually, when you shorten hydraulic residence time, the reaction becomes incomplete. The conversion from nitrous oxide to nitrogen gas, which is harmless and goes to the atmosphere is the last conversion. If there's not enough time, a higher percentage of nitrate goes off as nitrous oxide. In these bioreactors, the conversion was quite complete and there was not a greenhouse gas increase."

Feyereisen had hoped to test even shorter residence times using the added carbon, but a biofilm developed through the process which clogged the system and reduced effectiveness. Researchers are now working to address ways to prevent the biofilm development.

In the Field

At the University of Minnesota Southwest Research and Outreach Center (SWROC) in Lamberton, researchers use a small 300-acre watershed to evaluate various water and nutrient management practices. The site includes in-field, edge of field and beyond the field tactics including cover crops, controlled drainage, constructed wetlands and bioreactors.

“Bioreactors are one component, but our goal is to see how good we can make the water coming out using these combined systems,” says Jeff Strock, a soil scientist with the SWROC, whose research focuses on water and nutrient management. “There are distinct advantages and disadvantages to each system. It’s going to take multiple drainage water management systems on a landscape or farm in order to maintain ag productivity and profitability while trying to meet environmental goals.”

Strock partners with Feyereisen to take benchtop research to the field level.

“His [Feyereisen] work lays the foundation,” Strock explains, “we take it to see how it translates from the lab to the field edge.”

Strock says bioreactor work at the SWROC spanned many years and included testing various media and bioreactor designs. Experiments even include the introduction of heat to the bioreaction chamber through solar panels to keep microbes active during colder months.

Strock’s work confirmed Feyereisen’s research that a vertical bioreactor supplemented with additional carbon can reduce the time water spends in the bioreactor while still achieving substantial nitrate removal. While largely proven, the concept still has plenty of hurdles that need to be cleared.

“One of the things we discovered was the water quality aspect works because of the hydraulic residence time,” Strock says. “Horizontal bioreactor designs take 12 to 24 hours for the water to leave. With the vertical flow, residence times are between 2 and 4 hours. We’re reducing a lot of nutrients really fast. That translates to the field as well.”

“If we can cut the time to two hours to treat the same amount of water, a bioreactor could be one-quarter the size,” Feyereisen says. “That’s one difference that this research could make. It’s not that we can just make smaller bioreactors and turn up the flow, we have to have more available carbon, which comes from the corn cobs and the added carbon.”



The Next Phase

Feyereisen says dozens of denitrifying bioreactors function in the Upper Midwest. Some are used for research while others are fully functioning.

“They’re out of the incubator, so to speak,” Feyereisen says.

Scientists know the concept works, but they are focused on refining the process to make bioreactors more efficient and economical. Adding the carbon to the corn cobs and wood chips is still experimental for nitrate removal but results so far are encouraging. Researchers also want to evaluate if bioreactors are usable for the removal of other nutrients besides nitrates from drainage water.

“As long as water is passing through some treatment device, we’d also like to remove the phosphorous which can be difficult to capture and hold,” Feyereisen explains. “Phosphorous tends to build up in bioreactors or wetlands. With a big storm or flush, it can be washed out. It’s really hard to come up with a phosphorous sink that removes phosphorous from the system.”

Feyereisen says the next phase of bioreactor research will include discovering how much flow is realistically treatable. Because drainage water often comes in big storms and the flow is so fast, some water bypasses the treatment system. Researchers are still working out how much can be treated and evaluating the cost of that treatment.

“Bioreactors are one component, but our goal is to see how good we can make the water coming out using these combined systems.”

—Jeff Strock

System Economics

Every management practice has an economic component. Engineering and installing a bioreactor takes money. During challenging economic times, installing management systems to improve water quality without any compensation is a difficult sell to most farmers. Understanding how much environmental benefit is actualized through a bioreactor can help set a value.

Feyereisen says monitoring equipment will be placed on a bioreactor system already operating near Blue Earth to measure nitrate levels flowing into the system and how much is coming out.

“When it comes to paying people for conservation for things like cover crops, for example, you don’t really know how much improvement you’re getting in that specific case. But when you’re measuring the concentration and load going into a device and out, you know what was removed,” Feyereisen says.

Value-Added Opportunity

Improved drainage water quality may be the primary goal of denitrifying bioreactors, but there is also a value-added component. While most current functioning bioreactors are wood chip-based, some have been modified to include corn cobs in the base media.

Bioreactors require a recharge. The carbon source hosting the microbes only lasts so long and depends upon water flow. Bioreactors must be cleaned out as they can fill with sediment. This process may only be necessary about every 10 years, but it provides the optimal time to introduce corn cobs to the process.

“I’m excited to see how well corn cobs have performed in the bioreactors,” Doering says. “Farmers produce corn cobs and the technology is there to collect cobs. When bioreactors have to be cleaned, remaining nutrients can be land applied as fertilizer. So not only can the cobs help improve water quality, they can also help replenish the soil. All while utilizing a farmer’s product.”

Next Steps

Feyereisen and Strock know the bioreaction process works for converting nitrates to nitrogen gas, but it needs to make sense economically, so research continues.

“Our goal is to take one more step,” Strock says. “We’re building on what we’ve learned.”

“AURI is funding research that helps advance the technology so that it’s more economical for farmers,” adds Becky Philipp, AURI project manager. “The research also continues to be applied and built upon stretching the value of the funding further yet.”

It will likely take some time and refinement before producers rely heavily upon bioreactors for nutrient removal. However, the potential is too good to ignore.

“Water quality issues are not going away,” Doering says. “If we can use agricultural byproducts and residues to help solve another agricultural issue, that would be a huge win.”



The published peer-reviewed journal article is available at Agricultural & Environmental Letters
via the following link: <http://dx.doi.org/10.1002/ael2.20024>

AURI CONNECTS' NEW PROGRAM: FIELDS OF INNOVATION

AURI WORKS TO BUILD A NETWORK AROUND NEW AND EMERGING CROPS IN MINNESOTA.

BY AURI

The Agricultural Utilization Research Institute (AURI) launched a new program called Fields of Innovation, which focuses on bringing together Minnesota's ag and food value chains to build capacity and successful commercialization of new and emerging crops.

Created as part of the AURI Connects sub-brand, Fields of Innovation will take a contemporary, cross-platform approach to content sharing and connection building. The program will combine virtual and in-person events with an online networking group and resources. The first virtual Fields of Innovation events will take place in October 2020. Events will highlight promising new crops, examine market opportunities and production practices, as well as create awareness with participants on new technologies that can expand markets for existing crops.

"Fields of Innovation is a dedicated platform to share information with Minnesota's agricultural industry around new and niche crop opportunities," says AURI's Executive Director Shannon Schlecht. "I hope this platform will result in adding another crop alternative for producers to consider in parallel with awareness of new ingredients for processors to utilize. We hope engaging the entire value-chain in integrated discussions will accelerate new and niche crop adoption by creating connections around the demand and supply needs, with the goal of mitigating risk and adoption concerns."

The Fields of Innovation program took its initial inspiration from the Minnesota Renewable Energy Roundtable (MNRER), another AURI Connects program. Since 2006, the MNRER has served as a platform to proactively address challenges and

opportunities in renewable energy, specifically related to energy derived from agricultural crops and biomass. Action from the MNRER often relates to creating new ventures and collaborative research projects, spurring technology awareness, improving operating efficiencies at the processing level, understanding workforce needs, and networking for more than 500 individuals from 200 organizations across the state, region, nation and globe.

Like the MNRER, Fields of Innovation aims to offer a platform for AURI, its partners and other interested stakeholders to come together to advance markets and uses for new and emerging crops in Minnesota. Connecting innovation and market development, Fields of Innovation aims to build a strong ecosystem for new and emerging crops, giving the state's ag producers and value chain partners new, sustainable options to diversify and thrive.

"Value-added agriculture begins with what our farmers produce and relies upon linkages from the farm all the way to the consumer," says Jen Wagner-Lahr, AURI's senior director of commercialization. "Innovations in new crops, new technologies and changing consumer demand all offer tremendous opportunity to create new linkages and new value-added ag products."

With its multi-crop focus, Fields of Innovation aims to provide a clearinghouse for the latest crops by creating opportunities for stakeholders to expand their networks, identify synergies in efforts and build new collaborations.

Outside of scheduled events, a key component to this effort will be the Fields of Innovation Facebook

group. This online networking opportunity will allow any interested parties to receive the latest updates in emerging crops and engage other interested members in discussions with other members.



Learn more about Fields of Innovations at www.auri.org/fields-of-innovation/.

Subscribe to get the latest email updates!

"If you are thinking about bringing a new crop to market in Minnesota, we want to hear from you," says Matthew Leiphon, the Project Manager for Fields of Innovation. "We want this to be inclusive and action oriented. Part of the value of Fields of Innovation's multi-crop approach is that we can build the program to fit the conversation's needs. We can do an event focused entirely on one crop or we can bring in people focused on multiple different crops and technologies that fit a certain niche."

Fields of Innovation's initial programming will focus on current AURI projects with Kernza® perennial grain, winter camelina, pennycress, alfalfa and hemp. New market opportunities such as ecosystem services markets and unique varieties of traditional crops will also be included in future agendas. To learn more about the program's current offerings, go to www.auri.org/fields-of-innovation/.

NEW AND EMERGING CROPS IN MINNESOTA

Alfalfa

While alfalfa is not a new crop in Minnesota, AURI is currently working with researchers at the University of Minnesota to establish a more diverse portfolio of high-value, alfalfa-based products. Development of new and emerging processing technologies and applications may add non-ruminant uses to alfalfa-based products, potentially providing Minnesota producers with new, profitable marketing options.

Camelina

Camelina, is a short-season oilseed cover crop high in both oil/fat (30-38%) and protein (25-30%) Thus, it can be used to produce both oil and protein ingredients. For camelina to be a feasible source for plant protein, more research is necessary on extraction methods, processing technologies, functionality and nutritional quality. AURI is currently working with Central Lakes College, University of Minnesota Forever Green Initiative and other partners to address these questions and identify uses for camelina in the food, biofuel, bioproduct and livestock feed industries.

Pennycress

Being an oilseed crop, pennycress has high oil/fat and protein content. AURI experts are conducting research and outreach aimed at commercializing

new pennycress-based products and technologies as part of a multi-partner, five year, \$10 million project funded by the USDA National Institute of Food and Agriculture (USDA-NIFA). These research efforts are focused on optimizing and increasing production and building sustainable supply chains for the crop in the Midwest and beyond.

Hemp

The production of industrial hemp became legal in Minnesota after the 2014 Farm Bill shifted the responsibility of regulating hemp farming from the federal government to the states. Its production is still limited and heavily controlled. In 2016, the Minnesota Department of Agriculture (MDA) began its first hemp pilot program with 37 acres being planted the first year and 2,100 acres the second. Currently, there are few Minnesota processors of industrial hemp and only processed (non-viable) seed can cross state borders.

Kernza®

Kernza® is a new domesticated grain introduced by The Land Institute that is now being developed for commercial use in Minnesota. It originates from a forage grass called intermediate wheatgrass (*Thinopyrum intermedium*) and is a cousin of wheat. AURI is working with the University of

Minnesota Forever Green Initiative and Stearns County Soil and Water Conservation District (SCSWCD) to identify and test new commercial uses for Kernza®. Grain harvested this year from plots in Minnesota will be used to test and develop new food and beverage products and pursue pilot projects in collaboration with central Minnesota businesses.

Ecosystem Services

Ecosystem services is an emerging market opportunity that spans the agriculture and food value chain. The environmental benefits that specific agricultural practices provide—such as clean water and air, flood prevention, healthy soils, greenhouse gas reduction, and wildlife habitat—are collectively known as ecosystem services. When ecosystem services can be measured and quantified—for example, the amount of carbon stored in soil—they can be bought and sold through markets known as ecosystem or environmental markets. Numerous opportunities are on the rise for supply chain market development outside of formal carbon and water quality traded credits. This includes strategic supply chains focused on transparency and traceability, habitat and biodiversity, regenerative agriculture practices, waste-to-energy and other "seal of approval" or "sustainably-sourced" standards.

GROW NORTH

BY AURI

Grow North has grown significantly since its 2017 inception. Part of the Holmes Center for Entrepreneurship at the University of Minnesota, Grow North is dedicated to actively supporting food and ag entrepreneurship and innovation in Minnesota. Now, with a new Executive Director, Grow North is poised to take the next step in its evolution.

Grow North's new Executive Director, Allison Hohn, recently spoke with AURI about her role in leading strategy and growth for the organization.

What does the public need to know about Grow North?

Grow North is here to serve the food and ag community by providing education, resources, connectivity and opportunity. We are working to make scaling and growth more achievable for local companies. We have many small companies that are doing really well and have jumped from commercial kitchens to co-man[ufacturing], and ultimately to their own processing. Some big barriers can inhibit this critical process, so we are rallying greater investment in scaling this community to create more successful acquisitions and exits, like the BOOMCHICKAPOP and the Talenti successes.

Why did you want to serve as Grow North's Executive Director?

I discovered that coaching and mentoring and just generally helping people were where I found meaning and joy, and this was a unique opportunity to be a coach and "Hype Woman" for a community I am passionate about. It began when I started coaching soccer about a decade ago. In the last five years, I found more opportunities to mentor startups through accelerators at companies I worked at and through consulting. And I absolutely loved it because this is the real-world application of my expertise as a food scientist and business leader, in a coaching scenario. To use a Target-ism, "it's what brought me joy!" So being able to do that for an entire ecosystem really was a no brainer for me. It was a way to not just help one-off here and there, but an opportunity to actually scale that impact across the entire food and ag community.



How will your background and professional experience help you support Grow North's mission?

I spent much of my former career as a diehard food scientist at both Land O'Lakes Inc. and Target. So, I have a very deep and abiding appreciation for just how much work goes into product development and bringing products to life both on the science side, but also as an entire supply chain.

I transitioned to Target after I earned my second master's degree in supply chain and gained much more experience in developing and executing business strategies and how to manage an entire area in the grocery store. It was a lot of the decision making that happens at the shelf at a big-box retailer.

I come to Grow North with experience across the food value chain; from the co-op, agriculture, and CPG companies to the big-box retailer; and sprinkled in there is the intimate knowledge of the unsexy side of the connected supply chains and the layers of startup mentoring. It's a unique mix of experience and passion that positioned me for this role and to speak to all the different aspects a company has to deal with. It puts me in a good position to help companies and to understand what they're experiencing.

As Grow North's new leader, what are your biggest goals and priorities?

Growing Food | Ag | Ideas Week is a big one and with COVID, this year's event will look a little different being virtual. But the goal is to maintain the level of depth and quality of content this community expects.

Another priority is sharing with the entire community what resources are available and accessible and lifting up and serving underserved communities. Many people know about Grow North, but barriers exist. I want to remove those barriers, so everyone has access. Additionally, we will launch a membership model for the community-at-large, so preparing for that would be a huge step for doubling down on connectivity and convening for this ecosystem.

Finally, we want to expand access to early-stage capital across the Minnesota food and ag community. Many companies can't make the jump from friends and family financing to growing beyond. We are working toward a more targeted approach on how we can engage pre-seed and seed investors from outside the area to invest money here or build it up internally.

For more of AURI's interview with Allison Hohn, go to www.auri.org.



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DAIRY CHECKOFF SUPPORTS DEVELOPMENT OF NEW TACO BELL MENU ITEMS

BY AURI

Recently, fast food company Taco Bell unveiled two brand new products thanks to checkoff dollars from the dairy industry.

The new products, a Grilled Cheese Burrito and a Pineapple Whip Freeze beverage, were the result of brainstorming how to give dairy a more prominent position on Taco Bell's menu, says Mike Ciresi, a Dairy Management Inc. (DMI) senior dairy scientist who works at Taco Bell's headquarters in Irvine, California.

Development of the Grilled Cheese Burrito had the goal of putting a Taco Bell spin on a traditional comfort food. "Grilled cheese is a classic that everyone knows and loves," Ciresi said. "What makes it so special is not only does it have classic Taco Bell fillings on the inside, it features a flavorful layer of indulgence on the outside that gives you a delicious, gooey, grilled cheese experience."

The Pineapple Whip, released on May 21, is the chain's first beverage to contain dairy since Taco Bell and DMI formed a partnership in 2012.

"We knew that dairy was a huge menu gap on Taco Bell's beverage menu," Ciresi says. "They didn't have any beverages with dairy so through some insights and some learnings with consumers we knew that was definitely an opportunity."

Delivering a dairy-based beverage would be challenging to execute in Taco Bell locations because of the limited resources and equipment to handle dairy beverages in stores. In order to solve this issue, DMI's Global Innovation Partnerships science team worked to create a dairy-based, shelf-stable creamer that consists of real cream and met Taco Bell's product requirements.

"Taco Bell has always wanted an indulgent beverage to fill a menu gap, but the setup of its restaurants made it challenging," Ciresi said. "That caused us to think



differently because we knew we could make a delicious dairy beverage that didn't need refrigeration. We were convinced there was a way to do it and our work with the Midwest Dairy Center proved that it was possible."

The Pineapple Whip Freeze has exceeded the chain's expectations. It is available for a limited time or until supplies run out.

Ciresi said these projects show the benefit of having dairy scientists on site at a major chain's headquarters. "We started the partnership in 2012 and it's been a really great partnership," he says. "A lot of successes over the years, a lot of new product launches."

Collectively, checkoff partnerships have grown U.S. dairy sales by 2.2 billion milk equivalent pounds and averaged 3 percent growth since their creation.

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