Prairie Swine Centre Testing Nanotechnology Applications In Pig Industry

Prairie Swine Centre Inc.

Nanotechnology – it's a word most people come across while watching science fiction movies, but it's become a modern reality. But what exactly is it? And how can it help push the pork industry forward into a new future? That's precisely what the Prairie Swine Centre wanted to discover with a recent research project.

But first, what is nanotechnology? Nano basically means small... really, really small. A nanometer is one millionth of a millimetre. To illustrate just how small, consider that a normal, healthy fingernail is just one millimetre thick. Nanotechnology is all about harnessing the power of individual atoms and molecules at a very small scale to make a really big difference. For example, zinc oxide nanoparticles, (which are between one and 100 nanometres in size) are used in transparent sunscreens to block out the damaging rays of the sun.

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So, what does all that have to do with raising pigs? As it turns out, potentially quite a bit.

"We wanted to see if we could control the growth and transmission of disease-causing microorganisms in swine barns through the use of nanotechnology," said Dr. Bernardo Predicala, Engineering Research Scientist at the Prairie Swine Centre, and the project's lead.

Disease spread during swine production is usually controlled through two distinct methods – biosecurity and sanitation. Biosecurity involves protocol, policies and procedures that reduce the risk of initial contamination and subsequent spread of a pathogen within an operation. This can include practices such as showering in and out, Danish entries, and ensuring staff, guests and visitors don't pose a health risk to the herd.

Battling disease on the sanitation front means treating the environment to reduce the level of possible pathogens that could make animals or people sick. This can include the proper cleaning and drying of barns and trucks, and applying the correct disinfectants in the correct volumes to reduce the risk of illness. In other words, biosecurity is about preventing infectious agents from entering the barn, and sanitation is about controlling and reducing infectious agents that may already be present in the barn.

While biosecurity and sanitation efforts are always improving and evolving, so are the pathogens they seek to contain. The industry has changed too, and sometimes, with greater efficiency comes greater risk.

"The swine industry has shifted toward production systems where more animals are raised in larger facilities. These changes have increased efficiency, productivity and profitability, but it's also increased the risk and prevalence of animal diseases," said Predicala.

That's why scientists are constantly looking for new ways to manage and mitigate health risks. Not only is a healthier herd better for productivity and profitability, but it's much better for the pig – and animal welfare is an increasing priority to the public and to producers alike.

"Nanoparticles are known to have antimicrobial properties," said Predicala. "They've been used in water treatment and purification, as well as in air filtration systems in hospitals to provide a clean environment for patients, especially during surgery."

Predicala, along with Prairie Swine Centre engineering research assistant Alvin Alvarado, wanted to investigate how nanoparticles could supplement the safeguards already provided by biosecurity and sanitation measures. But that's not all – the research could also determine whether the novel nanotechnology application could also help manage gas emissions – an inevitable byproduct of swine production.

"If proven effective, with a single treatment application, we could simultaneously address concerns with hazardous gas emissions as well as the spread of disease – both which greatly affect the profitability and sustainability of livestock operations," explained Predicala.

Predicala and Alvarado designed a research project conducted right on site at the Prairie Swine Centre. But first, the effectiveness of a variety of commercially available nanoparticles in controlling the growth of certain pathogens had to be selected. In order to do that, laboratory scale experiments were conducted at the University of Saskatchewan to determine which nanoparticle would be most effective. The results showed that zinc oxide (ZnO) was the clear winner.

The next step was to bring the ZnO nanoparticles to the Prairie Swine Centre facility to assess whether the nanoparticles could really pack the punch the researchers were looking for. Two identical controlled-environment chambers, each 4.2m x 3.6m x 2.7m, were used to conduct the first portion of the research. Each chamber was fully instrumented and had identical environmental conditions, and each housed a pen of the same size. The chambers were operated with a negative pressure ventilation system.

Next, a filter was installed into each of the

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in preventing industry; the cost of implementation including training and maintenance; acceptability to workers and worker recommendations for improvement; local barn or company characteristics that help or hinder effective implementation; and overall return on investment relative to any changes in injury or productivity.

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On the lookout for new solutions and test facilities

Lab tests are fine for some things, but to make sure these solutions can be applied successfully in industry we need to assess them in a real-world setting. This means we'll be on the lookout for appropriate solutions to the problems we identify, and also the right environments in which to test them. For example, our first solution to assess will be needle-less injectors.

Needle-less injectors have been gaining popularity on pig farms for productivity reasons. They eliminate risk of needle-stick injury, but may increase musculoskeletal exposures and lead to injury. It is unclear whether needle-less injectors have a net health and safety benefit. This project aims to address that gap with a comprehensive evaluation, including investigation of: Injury rates, Worker preferences, Measured musculoskeletal exposures like grip force and repetition, Productivity, and Overall cost-benefit and return on investment. This means we'll be implementing the needle-less injectors in a few barns and observing the effect on worker symptoms and productivity. We'll also meet with workers and barn managers to identify challenges and find the best ways to make the transition smooth. Lastly, we'll track the costs and weigh them with the potential benefits so that producers can make an informed choice about when to adopt a new method or technology.

We know from previous research that there are some things that can be done to maximize the chance for success when introducing a new method. New controls are generally more successful when they have:

1. Organizational support and involvement at the top, where management not only says safety is important, but shows it by ensuring the time, funding, and resources are available to make the control successful.
2. Safety included as a business priority, demonstrated by incident tracking and OH&S systems, including safety in performance evaluations, and preventing loss by helping low performers
3. A local champion — perhaps a worker representative or manager who is already engaged in Occupational Health and Safety issues.
4. Engaging workers throughout the process to address constraints and motivate buy-in.
5. Adequate communication of the project's goal, what will be done, timeline, and ways to give feedback.
6. Some pilot testing. Trial small before you go big, trial cheap (i.e. get feedback on the paper version) before you go expensive, and evaluate any new initiative before expanding the implementation.
7. Training reinforcement to encourage peer and supervisor modeling.

Moving forward

Injuries can take a bite out of profits, but they don't have to. With good benchmarking and adoption of proven prevention strategies, injury losses can be prevented to strengthen the bottom line and secure long-term viability. The number of options in potential solutions can be overwhelming, but a systematic and collaborative effort will help identify the good ones. Ongoing research is being conducted to test potential strategies, and will be communicated to producers via the Prairie Swine Centre.

Collaboration and participation from producers is vital to developing solutions that are going to work in the long-term, so we'd love to hear from you. Please feel free to contact us if you have an idea for a new safety solution, or if you are interested in participating in a barn trial.

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chambers' ventilation air recirculation systems – one loaded with nanoparticles and the other without. The trials were 15 days long, and the scientists monitored microbial loads both in the air and on surfaces, as well as greenhouse gases, manure characteristics and pig performance.

To measure whether the nanoparticles could help with sanitation, two levels of ZnO nanoparticles were sprayed on concrete surfaces and compared to the control, which was treated with the standard chemical treatment ordinarily applied.

The results from both phases of the experiment were encouraging.

"Partial filtration of the air in the chamber with the ZnO nanoparticles did achieve a reduction in bioaerosol levels in both the human and the animal-occupied zones," said Predicala, adding it was important to note that the nanoparticles didn't appear to negatively affect any other measured aspects of swine production. "There was no significant impact on carbon dioxide and methane emissions, manure characteristics, or pig productivity."

The ZnO particles were shown to be effective in controlling the growth of certain commonly encountered pathogens such as Salmonella and S. suis. Also, the filtration system could be improved, further reducing bioaerosol pathogens with better air capture, and forcing more air to pass through the treated filter.

The sanitation experiment showed that the nanoparticles can indeed make a big difference by inhibiting the growth of microorganisms and in fact, could be a better option than conventional disinfectants. Of course, new technologies not only have to work, they have to be reasonably priced in order for any potential implementation to make sense. In that regard, the sanitation nanotechnology was ahead of the filter application.

"Currently, the use of the nanoparticle solution during sanitation was only about 12 cents higher than the use of conventional disinfectant," explained Predicala. "The cost of filtration treatment with ZnO nanoparticles has to come down significantly before it can be a practical barn application.

Predicala and Alvarado recommend pilot-scale testing in other parts of the barn such as the nursery, breeding, gestation, and farrowing areas to further determine the feasibility of both the sanitation and the filter nanoparticle applications.

"It would also be useful to conduct trials at higher recirculation rates, which would likely have a better impact on reducing bioaerosol levels," said Alvarado.

The full version of the study report can be found at prairieswine.com.