

FROM IDEA TO IMPACT:

Ontario innovation revolutionizes food safety





Dr. Keith Warriner, University of Guelph

Introduction

While cleaning our food seems simple, it creates a bacterial conundrum. Water is used to wash food after harvest, yet it can also spread those contaminants. The water used in food production operations can actually take the very things we're trying to remove and carry them to food, equipment, soil, and more, which can lead to the types of outbreaks that washing is meant to prevent. This is the problem Dr. Keith Warriner set out to solve:

How do you wash or clean food without water?

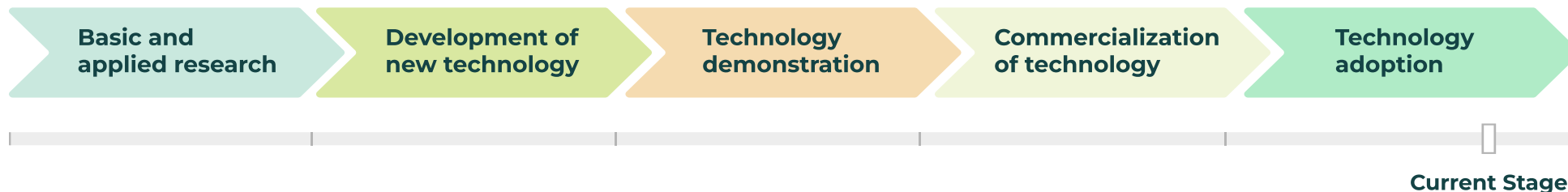
Dr. Warriner is a renowned food safety expert in the Department of Food Science at the University of Guelph. Having worked on this technology since 2002, he partnered with Canadian fruit grower Paul Moyer and worked with his team to develop a system that safely decontaminates food without water. What's more, the system kills pathogens more effectively than traditional washing systems and contributes to Ontario's focus on food safety, water quality and quantity, and sustainable production systems. However, projects like this need funding to get from idea to impact.

"If you don't get funding, you can't pay stipends to students. If you can't pay stipends to students, you can't do the research. So, funding initiatives like OAFRI oil the wheels of research. Without it, you don't go anywhere."

— Dr. Keith Warriner, University of Guelph

OAFRI's Innovation Continuum

In 2002, Dr. Keith Warriner began a 23-year journey exploring water-free food decontamination. Starting with applied research, it is now a commercialized technology adopted across multiple commodities.



Greenbelt Organic Greens, client of Clean Works

Growing Ontario's agri-food sector

OAFRI is a government initiative overseen by the Ontario Ministry of Agriculture, Food, and Agribusiness (OMAFRA) to provide funding for agri-food research and innovation projects in Ontario. It is a key pillar of the Grow Ontario Strategy, which aims to promote Ontario's agri-food products, workers, food, and technology and take action to make Canada a world leader in research and innovation.

The initiative is jointly funded by the governments of Canada and Ontario under the Sustainable Canadian Agricultural Partnership (Sustainable CAP), a five-year, federal-provincial-territorial initiative. Dr. Warriner's project is just one example of research made possible by this funding.

Safer food, better systems

For Dr. Warriner, the importance of developing a new form of water-free food decontamination goes back to 1996 when he became involved in the scientific testing of a post-harvest wash process for salad spinach.

"We evaluated the wash process for salad spinach, and sure enough, it didn't remove microbes. It actually spread contamination."

— Dr. Keith Warriner, University of Guelph

When he moved to Canada in 2002, he applied for his first round of government funding from the Ontario Ministry of Agriculture, Food, and Agribusiness (OMAFRA). Dr. Warriner's project was a natural fit as an innovative technology with the potential to improve food safety, strengthen Ontario's agri-food supply chain, and train new talent in the agri-food industry.

With the help of that early OMAFA funding, Dr. Warriner tested a combination of ultraviolet (UV) light and vaporized hydrogen peroxide to disinfect food, a combination he had previously seen used to sterilize carton packaging in the UK. As he continued his work over the next decade, he became known in Canada as a leading professional on food safety and sanitization. In 2014, he caught the attention of a valuable partner.

Enter Paul Moyer of Moyer's Apple Products, a fruit grower making caramel apples in Canada's Niagara Peninsula. While his business wasn't connected to a recent *Listeria* outbreak on caramel apples in the U.S., he wanted to show retailers that it was safe to sell his apple products. OMAFA connected him with Dr. Warriner.

Paul and Dr. Warriner began collaborating on the technology to meet the needs of Moyer's Apple Products, starting with an integrated conveyor belt system to decontaminate Paul's produce at the volume and speed he required. Dr. Warriner then implemented ozone gas to make the process more efficient and effective. This led to another big leap. Despite working on the technology since 2002, Dr. Warriner had yet to find a commercial application for his research or technology.

"The reality is, academics are not always the best salespeople. You need a champion, and Moyer's Apple Products was that champion."

— Dr. Keith Warriner, University of Guelph

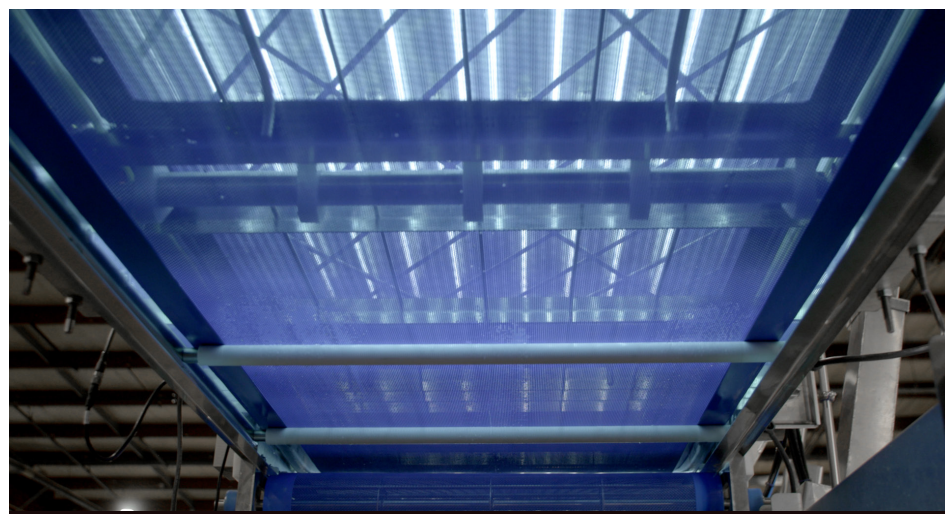


The decontamination process increases the shelf life of produce by an average of

25%



Dr. Warriner demonstrating the decontamination method



The UV lights used alongside hydrogen peroxide and ozone

With the new innovations, Paul Moyer, along with Court Holdings, was able to patent the technology to form Clean Works, a business to market and sell the decontamination process to the agri-food industry and beyond. But once again, the team found that government funding could help ease the process.

“It’s very hard for a little caramel apple company or a startup like [Clean Works] to be able to do the testing and other essential steps without those grants. The [money and help] we received were paramount in getting the project done.”

— *Paul Moyer, Moyer’s Apple Products*

Today, Clean Works uses UV light, vaporized hydrogen peroxide, and ozone to generate hydroxyl radicals, which kill up to 99.99% of pathogens. The technology is water-free, sustainable, and eco-friendly. The only byproducts of the process are water vapour and oxygen, making it truly waste-free. The technology has been validated by 207 third-party studies.

Awards

2017

Food Safety Innovation Award
from the International Association
for Food Protection

2018

Leaders in Innovation Award
at the Summit on Agri-Food

2023

Environment Sustainability Award
at Canada’s Outdoor Farm Show

2024

**Grand prize winner for Novel
Technologies Streams** in the
Food Waste Reduction Challenge
at Canadian Innovation Week



Spinach in the Clean Works system

Innovation grows: From produce to poultry

With the success of Clean Works came another round of OAFRI funding from OMAFA in 2021 to expand the use of the technology beyond produce. It was time to try the decontamination process on eggs and poultry. This was a logical next step as Salmonella and Campylobacter are two of the main causes of bacterial foodborne illnesses, and both are found on poultry meat and eggs.

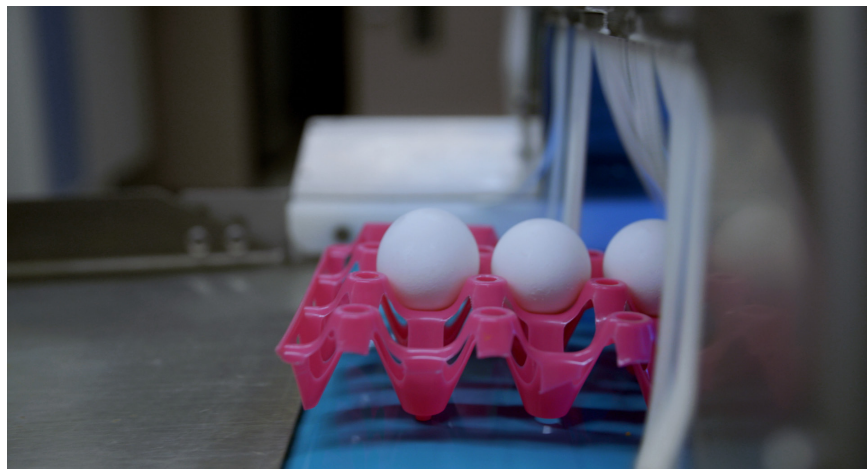
Thanks to OMAFA’s infrastructure investments into Agricultural Research and Innovation Ontario (ARIO), Dr. Warriner had access to the Ontario Poultry Research Centre, one of fourteen Ontario research centres owned by ARIO. This enabled practical trials on eggs and chicks, allowing him to communicate the effects and benefits to commercial hatcheries, which legitimized the technology and led two commercial hatcheries to adopt Clean Works technology.



Clean Works is a global company:

40+
installations

6
countries



Eggs entering the Clean Works system



Clean Works system in use at Greenbelt Organic Greens

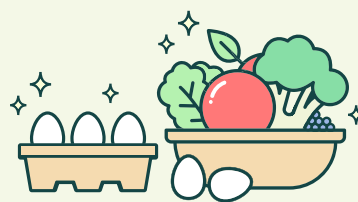
Dr. Warriner successfully eliminated both pathogens on the surface of eggs without negatively affecting the egg quality or protective outer cuticle layer, which was removed by many traditional methods. With poultry meat, he matched the current standard of pathogen elimination while removing water from the process. Better yet, by killing all pathogens, the process extended the shelf life of poultry by up to two days and extended the shelf life of produce by up to 25%.

Sharing knowledge with Ontario's agri-food sector

The use of Dr. Warriner's technology is now on the rise, but even the greatest innovations can disappear without making their desired impact on the world. The final stage of the development process is technology adoption, spurred on by knowledge translation and transfer (KTT) activities to teach others how it works.

"I think food safety scientists, retailers, and anyone in the supply chain [are] beginning to recognize that we need to seriously consider how to mitigate risks in the produce supply [chain]. It's about education. Stakeholders in the produce industry need to know this technology exists, and the benefits it has for their business."

—Tyler Hove, Vice President of Food Safety and Regulatory Affairs, Sobeys



Keith's system
decontaminates produce at

9000 lbs per hour



Paul Moyer, Moyer's Apple Products

With help from further OAFRI funding, Clean Works showcased its work to the agri-food industry at a Ball's Falls workshop in the Niagara region. The crowd included over 100 agri-food producers, retailers, and government representatives and has now caught the eye of larger organizations. As it continues to expand, Clean Works is exploring other applications, including frozen foods and indoor vertical farming. They're also looking at applying the technology directly to crops to help reduce or eliminate the use of chemical pesticides and fungicides.

"We will use about 1% of the water they would have [typically] used in fields and about 0.1% of the water post-harvest."

— Paul Moyer, Moyer's Apple Products

Dr. Warriner's research stands as a model of environmental stewardship and food safety and is a testament to the value of OAFRI funding in advancing innovation in Ontario's agri-food sector. The team at Clean Works is working hard to make a difference in homegrown food production, but more importantly, it's helping to change the public's perception of Ontario agri-food products.

"As a grower, I'm concerned that if we're not careful, the food industry and the consumer are going to start thinking that [artificial food products like doughnuts and soda] are safe and apples, romaine lettuce, and peaches are dangerous. And nothing could be further from the truth. When people [see an outbreak and say], 'I'm not so sure about romaine lettuce...' That's a problem that can be solved."

— Paul Moyer, Moyer's Apple Products

Learn more about Ontario research and innovation at **Ontario.ca/AgResearch**