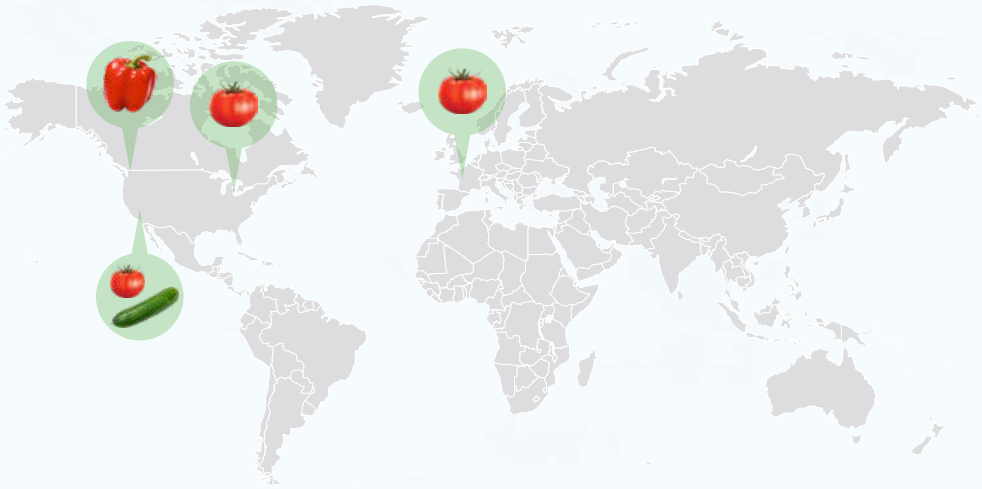
ecoation

Human KNOWLEDGE + Machine PRECISION

Integrated Pest Management

How the ecoation OKO platform uses sensors and AI to optimize IPM programs and reduce treatment cost in greenhouses.
Four cross-continental success stories.

ecoation is an award-winning grower-centric platform that merges deep biology, artificial intelligence, intelligence augmentation, and robotics to create products and services that change the way we produce and protect our food. Commercially available since September 2019, ecoation products can be found in greenhouses across the United States, Canada, Mexico, and European countries. ecoation's OKO platform provides three crucial greenhouse services: closed-loop IPM insights, yield production assessment, and crop work quality control. These success stories cover closed-loop IPM with great emphasis on biological programs.



Greenhouse Success Story Selection:

These success stories are collected from multiple greenhouses in Europe and North America from customers who use the OKO platform.

- **Case 1:** 15-hectare organic greenhouse in France, producing specialty tomatoes for the European market
- **Case 2:** 18-hectare pepper grower in Delta, British Columbia, Canada
- **Case 3:** 16-hectare greenhouse in Leamington, Ontario, Canada, producing beefsteak and cherry tomato
- **Case 4:** 50-hectare greenhouse in California, USA, producing tomato on the vine, cherry tomatoes and cucumbers

The success stories from these greenhouses were chosen to represent different climate and IPM challenges. Following ecoation's Privacy Policy, these greenhouses remain anonymous.

Impact Overview:

These success stories demonstrate the ability to use the OKO platform to:

- Optimize biological treatment cost
- Uncover inefficiencies in biological treatment programs
- Understand impact of microclimate on IPM
- Utilize ecoation risk projection models to optimize advance ordering of biological treatments

Case 1: Optimizing Treatment Cost

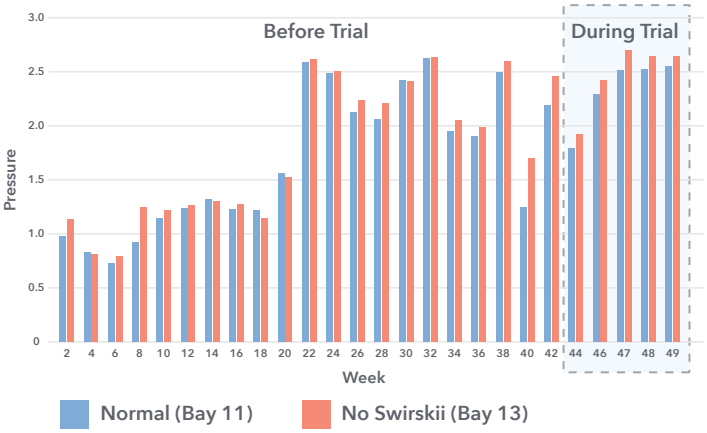
In Case 1's organic tomato greenhouse, the crop was threatened by the presence of **russet mites**. In warmer weather the mites establish a voracious population that, if unchecked, could cause undesirable russeting in the crop and unsellable fruit. Russet mite infestation presents a significant problem when using an interplanting strategy and must be managed throughout the season. Greenhouses that use an interplanting technique cannot perform a deep clean of the facility, so the pest population remains active year-round. The farm was highly proactive and utilized all permitted organic tools – insecticidal soaps, sulfur, and the predator ***Amblyseius swirskii***. The swirskii comes with a high price tag, costing up to 5 euros (about $7.80 CAD) per square meter per year. ecoation's objective was to **reduce the cost of treatment** while obtaining the same control.

The customer had two scouts regularly using the ecoation OKO cart to record pest pressure and climate for every row in the greenhouse. They engaged the ecoation team to help them quantify the effectiveness of their biological controls. The team used the **ecoation analytical platform** to assess the data which indicated that swirskii was likely providing very little control of the russet mites. Based on ecoation's initial assessment, the greenhouse management team decided to proceed with an **A/B trial**, where one bay was given no swirskii and a second bay was treated with standard swirskii dosage for comparison. The trial lasted for **6 weeks** during which time the russet mite pest pressure was monitored carefully with the OKO machine in the two test bays and the overall greenhouse as usual.

> **The grower team was presented with a new cost saving option: modify their preventative distribution plan of the swirskii control agent and save roughly €35,000.**

At the conclusion of the trial, the **ecoation analytical platform** assessed the trial data to determine whether a significant difference existed between bays treated and bays not treated. It was discovered that there was **no significant difference** in russet mite pressure between the bay that received swirskii and the bay that received none. In light of this result, the greenhouse management realized that extra expenditure on the biological control agent does not significantly improve their IPM strategy and they **saved money by optimizing their treatment plan.**

Biological control agents can be used in two ways: as prophylactic preventative measures and/or reactive treatments after an infestation is found. The preventative deployment of biologicals is usually costly and requires diligent monitoring of efficacy so growers can confirm efficiency, optimize deployment, and minimize their cost.



After reviewing the results and confirming the observations in the greenhouse, the grower team was presented with a new cost saving option: modify their preventative distribution plan of the swirskii control agent and **save roughly €35,000.** According to the results of this trial, this optimization wouldn't have a negative impact on the russet mite preventative management, but it would significantly reduce the cost by lowering the amount of biologicals they need to spread as well as the labour cost associated with the deployment of those extra biologicals. In this example, the OKO platform enabled the grower team to track russet mite populations and only intervene when necessary.

Case 2: Uncover Inefficiencies

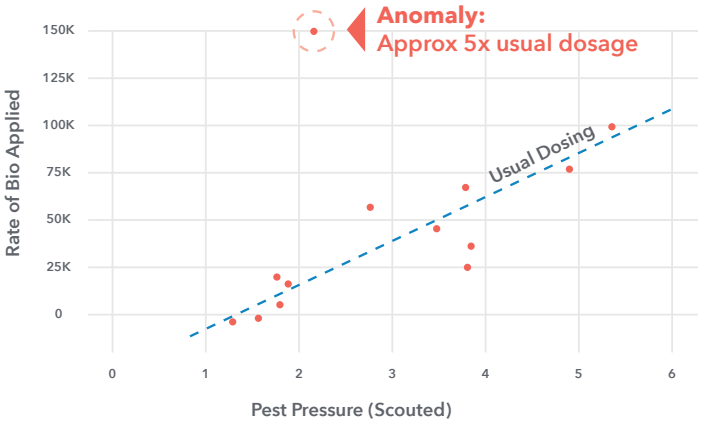
The pepper grower in this case is producing 45 acres of bell peppers under glass in western Canada. They take a proactive and data-driven approach to their integrated pest management (IPM) strategy, using a combination of biological and pesticide treatments. The objective of this trial was to **identify inefficiencies in the IPM plan of the greenhouse** while monitoring pest and biological population dynamics. The grower was interested in tracking their treatment rates and dates over the season to optimize efficiency, identify anomalies, and ensure action plan consistency when faced with similar pest pressure, climate, and crop stage challenges in the future.

This grower uses an **OKO Digital** for scouting in the greenhouse which enables them to **digitally record pest pressure** at specific

locations, derive insights from a sophisticated risk projection model that highlights where pests are likely to be found, and uses LCD Live Alerts to alert the scout whenever they are in an area of **higher pest & disease risk**. The IPM manager **recorded the treatment information** from the previous season which permitted the **ecoation AI platform** to analyze the data, detect anomalies, and determine any inefficiencies in the chosen treatment strategy applied in this greenhouse with respect to observed pest pressures and climate conditions. By analyzing and processing the typical treatment policy of the greenhouse, the **ecoation AI platform** was able to inform the IPM manager and greenhouse owner of said **relevant anomalies and inefficiencies** in the treatment strategy and as such, highlight opportunities for optimization.

> **The ecoation AI platform also uncovered a significant anomaly in week 20 where the persimilis treatment was applied at approximately 5x its typical rate.**

The IPM program at this greenhouse was running with exemplary precision. **ecoation's AI platform** revealed that the usual dosing of ***persimilis*** was well-correlated with the scouted pressure of spider mites which is exactly the kind of relationship needed for consistency and crop quality. However, the ecoation AI platform also **uncovered a significant anomaly** in week 20 where the ***persimilis*** treatment was applied at approximately 5x its typical rate. This was an opportunity to reduce costs from an unnecessary expense in the greenhouse.



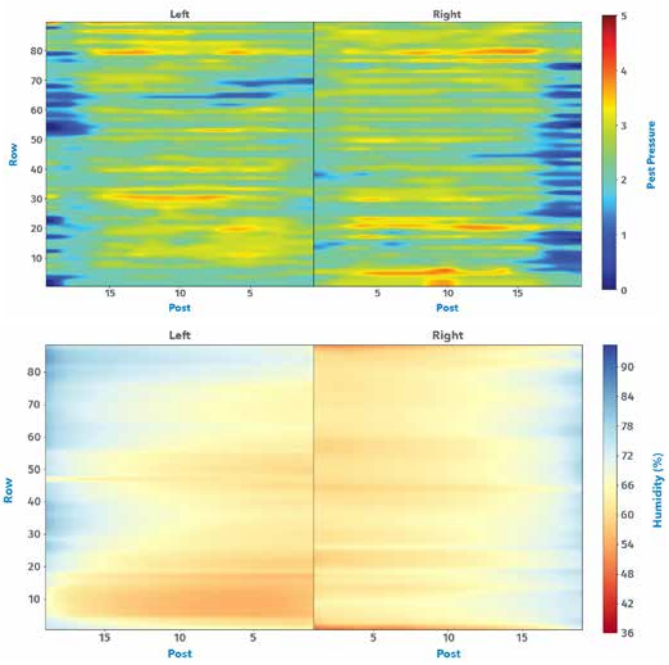
Biological control agents are expensive and perishable. Their dispersal is also labour intensive and costly. As such, treatment plans should closely follow the population dynamic of the pests and diseases to avoid incurring unnecessary expenses.

In some cases, the treatment plan does not match the infestation status and this misalignment introduces inefficiency into the operations. ecoation's AI platform can monitor both pest and disease population dynamics and treatment planning to assist growers in enhancing the efficiency of their IPM program. In this case, the IPM manager can initiate a review process where each order of biologicals is proactively analyzed for anomalies and over-ordering may be avoided to **reduce costs** from both biologicals and associated labour for their dispersal.

Case 3: Impact of Microclimate on IPM

The organic farm in Case 3 produces specialty tomatoes and experience problems with mites in their greenhouse. Their semi-closed greenhouse structure gives the growing team precise control over the climate which can be manipulated to achieve a certain cultivation strategy. The farm is highly proactive and utilizes all permitted organic tools. Even with these tools, every grower knows that the first step in a successful IPM program is cultural and mechanical control of the pests. During regular scouting with the ecoation

> **Using the KENNIS AI Platform and OKO Machine, the growing team was able to map the high risk areas for mites and monitor microclimate inconsistencies in their greenhouse.**



OKO system, they had noticed a tendency for increased mite pressure near the middle of the greenhouse and lower pressure near the greenhouse walls. The ecoation team used the **KENNIS AI Platform** to analyze how the pest pressure and microclimate was distributed throughout the greenhouse. This exercise uncovered the fact that the walls of the greenhouse had a consistent and significantly higher humidity than near the walkway. Where higher humidity was observed, mite pressure was lower. Using the **KENNIS AI Platform** and **OKO Machine**, the growing team was able to map the high risk areas for mites and monitor microclimate inconsistencies in their greenhouse.

The greenhouse utilized these insights to support their decision of changing the air distribution system within their semi-closed structure. With precise environmental control, they can create a climate that encourages high plant productivity while also being unfavorable to the development of mites. ecoation's OKO machine and AI platform enabled the customer to use climate control for IPM, therefore **reducing costs of biological control agents and crop loss.**

Case 4: Optimize Advance Ordering of Biological Treatments

The greenhouse in Case 4 grows tomatoes on the vine and cherry tomatoes while tackling ongoing spider mite issues. IPM staff regularly manage the mite population with weekly applications of ***persimilis*** predatory mites. The greenhouse scout operates the OKO machine four days per week to monitor IPM performance. With the help of LCD Live Alerts, the scout is warned when entering areas of high pest risk. Once alerted, the scout uses the OKO to enter pest pressures digitally, while the machine automatically records upper and lower climate variables for each post. The IPM manager regularly orders biological treatments on Wednesday afternoons, and the product is delivered the following Tuesday mornings. The IPM team has a short timeframe to deploy and distribute the biologicals throughout the crop, paying particular attention to any emerging hotspots. The challenge faced by the greenhouse is to **predict** what the **pest pressure and distribution** may be **one week into the future** for when the bios arrive.

> **The IPM manager uses this model to accurately project the pest development at the biological treatments' delivery.**

This prediction is impacted by several factors, including the existing pest situation, the climate over the coming week, and the prior treatments applied to the crop.

The pest pressure, climate, and treatment information are all regularly saved into the ecoation platform and organized by time and location in the greenhouse. Using this historical data, the ecoation team has developed an **AI model of the evolution of pest pressures across the entire greenhouse**. This model projects what the pest pressure and spatial distribution will be one week into the future. This projection is possible for all pests that were sufficiently observed by the scout and digitized through the OKO machine in the previous four weeks. When it's time to order the biological controls, the IPM manager uses this model to **accurately project the pest development** at the biological treatments' delivery. This means that the IPM manager is able to **accurately order** the inputs that are necessary to meet the real pest pressure in the greenhouse one week later.

The IPM manager can use the ecoation model projection once a week prior to ordering the biologicals. By doing so, the greenhouse can mitigate the practice of over-ordering out of precaution and benefit from labour and material **cost savings.**

Conclusion:

ecoation's Human+Machine Artificial Intelligence (AI) / Intelligence Augmentation (IA) OKO platform allows greenhouse growers to digitize their IPM data, aggregate their scout observations, and optimize their treatment strategies. Through automated 3D microclimate monitoring and diligently maintained AI algorithm capabilities, decision makers are able to analyze and optimize treatment strategies **therefore significantly reducing the cost of IPM**. As described in these success stories, the cost reduction is achieved through rate optimization, detection of inefficiencies, utilizing microclimate information as an alternative means of IPM control, and optimizing the treatment purchasing time given the perishable nature of the bios. **ecoation's mission is to provide a closed-loop IPM service where information informed by AI algorithms is accessible to decision makers at the earliest possible to get in front of problems and optimize actions.**

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