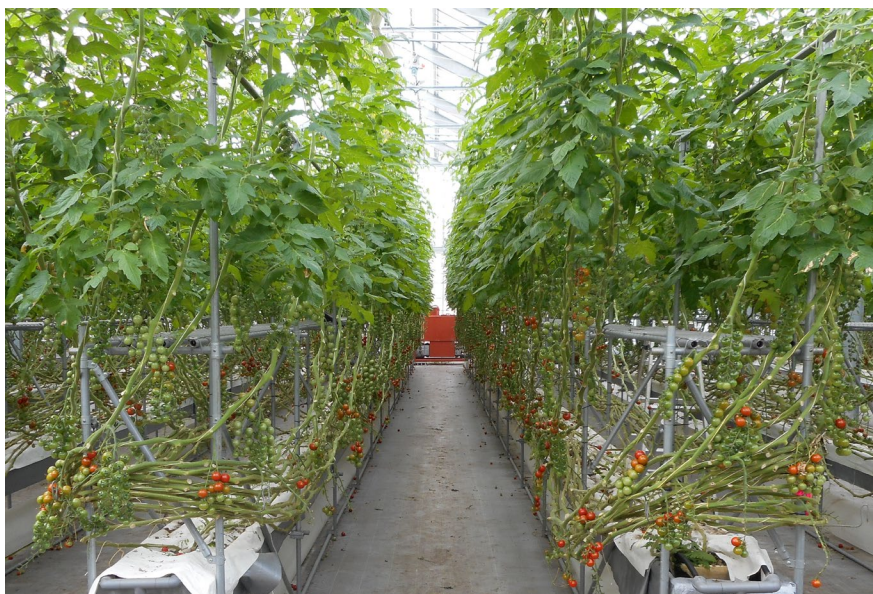


Visualizing temperature variations within a vinyl greenhouse through multi-point measurement!



Mini tomato farming



Tominaga Farm LLC
Mr. Tominaga

◆What crops do you grow, and on what scale?

We cultivate mini tomatoes. Our three vinyl greenhouses span a total area of 10,500 square meters (10.5 tan). Each greenhouse is divided into four sections, and our annual yield is about 15 to 18 tons per tan.

◆What kind of challenges do you face farming mini tomatoes?

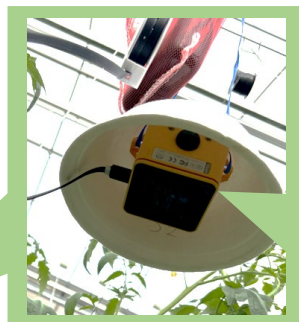
When growing crops in a greenhouse, differences in temperature from one location to another and variations in sunlight exposure are the two main factors that cause uneven crop growth. As for the second factor, there's not much we can do about differences in sunlight exposure, as this is unavoidable. As for the first factor, even though we heat the greenhouse from October through March to control the temperature, crops planted near the outer edges are more susceptible to temperature variations. Our biggest concern is condensation forming in areas where the temperature is lower. Condensation not only affects crop quality, but also increases the risk of disease, so we have to be very careful when managing the greenhouse temperature.

We used to grow our crops on the assumption that there would always be a 2 to 3°C temperature variation within the greenhouse. Although we did our best to minimize those temperature differences, we had no way to conduct quantitative assessments.

◆What were the key requirements for solving these issues?

Assuming there are temperature variations within the greenhouse, we expect that about 20% of the crop won't grow optimally because of those variations. To reduce the impact of temperature variations, we compensate by increasing the planting density near the outer edges of the greenhouse and retaining more leaves on those plants, helping to achieve more uniform growth throughout the greenhouse. Even with these adjustments, we can't always eliminate the problem. Areas with greater temperature variation or lower temperatures tend to have higher humidity, which is the source of disease. This is because some areas of the greenhouse are cooler than the dew point temperature measured by the sensor located in the center of the greenhouse, allowing condensation to form. The chance of disease goes up by 90% when left in humidity for a consistent period of 3 hours. High humidity on rainy days is something we have to accept. However, if the greenhouse remains humid for an extended period, it can become a breeding ground for disease. At that point, the issue isn't whether yields go up or down, but whether the crop can be grown successfully in the first place. The financial impact can be on the order of hundreds of thousands to millions of yen.

Improving greenhouse crop management through multi-point temperature visualization!



Measurement in the greenhouse



ECOREQUIRE main unit

◆What were the benefits of adoption?

We're grateful that we've been able to reduce the temperature variations. According to TTDC's measurements, the maximum temperature variation reached approximately 5°C, exceeding our assumed range of 2 to 3°C. This revealed that the greenhouse had greater temperature variation than we had anticipated. In addition, having better control over the greenhouse temperature has helped us reduce the risk of disease. Because condensation is always a concern, it's extremely valuable for growers to know how low they can safely lower the greenhouse temperature. Plants produce the energy they need to grow through photosynthesis, which is driven by sunlight intensity. As a result, growers use sunlight intensity to help control the rate of plant growth. For example, at this time of year, the daily solar radiation is around 12 megajoules, so we aim to keep the average daily temperature at about 17 to 17.5°C. On the other hand, when the weather is cloudy, there are times when we intentionally lower the greenhouse temperature. (Note: When temperatures remain high during cloudy weather, plants use the energy they've stored for respiration rather than growth.) For tomatoes, the minimum recommended temperature is 12°C, although ideally it should be maintained at 13°C or higher. Below 10°C, their development is delayed. If there's a 4°C temperature variation within the greenhouse and the heating is set to 12°C, the coldest areas could drop to 8°C. At that point, the plants' health begins to decline significantly. If we can keep the temperature variation within 2°C, we can safely use a 12°C heating setpoint because even the coldest part of the greenhouse will stay at 10°C or above. By reducing the temperature variation within the greenhouse, it's become much easier to determine how low we can safely set the temperature. This gives us greater control over the growing environment when we want to use the difference between daytime and nighttime temperatures to promote fruit development, and we expect it to improve plant growth even during the winter, when yields are typically lower.

As for the cost of implementation, visualizing the temperature distribution within the greenhouse allowed us to lower the heating setpoint to the lowest temperature that still avoids the risk of disease. The combination of improved yields and reduced heating costs enabled us to recover our investment without difficulty. Another advantage was that the device is compact and easy to handle. Unlike our existing environmental control system and temperature sensors, which all require wiring, this system runs on a portable battery and communicates wirelessly.

◆Could you tell us about your plans for the future?

As I mentioned earlier, plants generally tend to direct more of their energy toward fruit development when there's a larger difference between daytime and nighttime temperatures. When that difference is smaller, they're more likely to put their energy into vegetative growth instead. However, we still haven't determined what the optimal day-night temperature differential is. Our growing season doesn't end with the winter months, so we're hoping to identify that optimal temperature differential and apply it throughout the rest of the cultivation cycle.



From the left: Mr. Okada (TTDC),
Mr. Tominaga, and Mr. Kobayashi (JA Himawari)