

AIRMAR CASE STUDY

Enhancing Autonomous Agtech with Airmar's WeatherStation® Instruments



Introduction

In the rapidly evolving landscape of precision agriculture, autonomous sprayers are transforming how farmers manage crop protection. These advanced systems rely on accurate, real-time weather data to ensure compliance with environmental regulations, optimize spray application, and enhance operational efficiency. At the heart of this innovation is Airmar Technology Corporation's WeatherStation® instruments, which provide critical environmental measurements for autonomous Agtech platforms like SwarmFarm's SwarmBots.

SwarmFarm Robotics, a Queensland Australia based pioneer in autonomous farming solutions, has integrated Airmar's WeatherStation® instruments into its SwarmBots since 2019. With over 300 WeatherStations deployed in the field, SwarmFarm is leading the charge in autonomous spraying, helping farmers achieve higher precision, reduce chemical drift, and comply with stringent environmental regulations.

This case study explores how Airmar's WeatherStation® instruments enable SwarmFarm's autonomous sprayers to make real-time decisions, comply with regulatory requirements, and drive efficiency in modern agriculture.



Photo Courtesy of SwarmFarm

The Role of Weather Data in Autonomous Spraying

Autonomous sprayers are revolutionizing agriculture by reducing labor costs, increasing operational efficiency, and improving the precision of chemical applications. However, the effectiveness of these systems hinges on accurate, real-time weather data. Wind speed, wind direction, temperature, humidity, and Delta T (the difference between air temperature and dew point) are critical parameters that influence spray drift, chemical efficacy, and environmental compliance.

Regulatory Compliance in Australia

In Australia, spray applications are governed by strict regulations to minimize environmental impact and ensure operator safety. The Australian Pesticides and Veterinary Medicines Authority (APVMA) mandates that spray operations adhere to label instructions, which include weather limits, buffer zones, and application conditions. Additionally, state-based chemical use regulations often require farmers to record weather conditions such as wind speed, wind direction, temperature, and humidity during spray operations.

SwarmFarm's integration of Airmar's WeatherStation® instruments directly addresses these requirements by providing real-time, on-machine weather data. This data serves as a robust record of conditions at the point of application, ensuring compliance with APVMA label instructions and state-based spray record requirements.



Photo Courtesy of SwarmFarm

Global Agrochemical Regulations: A Growing Trend

Australia is not alone in implementing stringent agrochemical application regulations. Governments worldwide are increasingly enforcing environmental rules governing herbicide and fungicide spraying to protect ecosystems, water supplies, and public health. Key regulatory frameworks include:

- **United States:** The **Environmental Protection Agency (EPA)** regulates pesticide use under the **Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)**. State-level agencies, such as the **California Department of Pesticide Regulation (CDPR)**, impose additional restrictions, including buffer zones and wind speed limits.
- **European Union:** The **EU Pesticide Regulation (EC) No 1107/2009** sets maximum residue levels for pesticides in food and drinking water, while the **Sustainable Use Directive (2009/128/EC)** requires farmers to implement Integrated Pest Management (IPM) strategies and adhere to strict application guidelines.
- **Canada:** Health Canada's **Pest Management Regulatory Agency (PMRA)** oversees pesticide registration and use, with provincial regulations (e.g., **Ontario's Pesticides Act**) imposing additional restrictions on application timing, wind conditions, and record-keeping.
- **United Kingdom:** Post-Brexit, the UK enforces the **GB Pesticides Regulations**, which align with EU standards but include additional measures such as mandatory buffer zones near water bodies and real-time weather monitoring requirements.
- **New Zealand:** The **Hazardous Substances and New Organisms (HSNO) Act** regulates pesticide use, with regional councils imposing further restrictions, including mandatory wind speed thresholds and spray drift management plans.
- **Brazil:** The **Brazilian Ministry of Agriculture (MAPA)** enforces strict pesticide application rules, including buffer zones near water sources and mandatory record-keeping, with additional state-level regulations in key agricultural regions like Mato Grosso.

- **China:** The **Pesticide Management Regulations** require farmers to follow label instructions, with provincial agricultural departments enforcing buffer zones and application timing restrictions.
- **Japan:** The **Agricultural Chemicals Regulation Law** mandates buffer zones, wind speed limits, and record-keeping, with additional prefectural-level regulations in high-risk areas.

These global regulations underscore the critical need for **real-time, accurate weather data and equipment position logging** in spray operations. Airmar's WeatherStation® instruments enable farmers worldwide to comply with these diverse regulatory frameworks by providing precise, on-machine environmental measurements, ensuring safer, more sustainable agrochemical applications across diverse agricultural landscapes.

Industry Growth of Autonomous Sprayers

The global agricultural robots market is experiencing significant growth, with autonomous sprayers playing a pivotal role. According to Grand View Research, the agricultural robots market was valued at USD 7.4 billion in 2020 and is projected to grow at a compound annual growth rate (CAGR) of 23.1% from 2021 to 2030, with a market size of \$48.1 billion projected by 2030. This growth is driven by the increasing adoption of precision agriculture technologies, labor shortages, and the need for higher efficiency in farming operations.

Autonomous sprayers are a key segment within this market, offering farmers the ability to optimize chemical usage, reduce drift, and improve crop protection. SwarmFarm customers, with their fleet of over 300 autonomous SwarmBots equipped with Airmar WeatherStation® instruments, are at the forefront of this technological revolution.



Photo Courtesy of SwarmFarm

Airmar's WeatherStation® Instruments: Powering Autonomous Agtech

Airmar's WeatherStation® instruments are engineered to provide accurate, reliable, and real-time weather data even in the most challenging conditions. This proven performance has established Airmar WeatherStations as the preferred solution for autonomous systems operating on land and at sea across diverse markets. Each WeatherStation instrument delivers up to seven critical weather measurements, complemented by motion-based data from an integrated GPS/GNSS sensor, 3-axis rate gyro, compass, and accelerometers. The 150 WXRS model further enhances capabilities by detecting and measuring rainfall accumulation, intensity, and duration. Building on this robust foundation, the latest addition to the WeatherStation® family—the 300WX series—introduces advanced features specifically designed for agriculture, defense, and industrial applications.

Key Features of the 300WX Series

1. Dynamic True Wind Measurement:

- The 300WX instruments calculate both dynamic true wind from a moving vehicle (actual wind speed and direction relative to North, minus motion-induced wind speed and direction) and apparent wind (wind felt on a moving platform).
- This capability is critical for autonomous sprayers, as it allows the system to adjust spray parameters based on the true environmental conditions, not just the wind created by the moving vehicle.

2. Expanded Communication Protocols:

- In addition to CAN (NMEA2000®), the 300WX series includes J1939 and ISOBUS output protocols, expanding compatibility with agricultural, heavy machinery, and industrial systems.
- Automatic baud rate detection (250 kbps and 500 kbps) ensures seamless integration with existing vehicle networks.

3. Bluetooth® Connectivity via Airmar's CAST™ App:

- Users can configure sensors, view real-time data, and perform wireless firmware updates via the CAST™ app at distances up to 33 meters (100 feet).
- The app supports customizable data display layouts in digital, graphical, or hybrid formats, providing farmers with intuitive access to critical weather data.

4. Rugged and Maintenance-Free Design:

- The 300WX instruments feature a compact, all-in-one design with no moving parts, ensuring reliability and longevity in harsh agricultural environments.
- Models are available with IP64 and IP67 ratings, providing protection against water ingress, dust, and corrosion.

5. Comprehensive Environmental Measurements:

- The 300WX measures real-time apparent wind speed and direction, air temperature, barometric pressure, relative humidity (on select models), and calculated dew point and heat index.
- Wind speed accuracy has been improved to 1.5 knots RMS at 20 knots, supporting precise measurements in demanding conditions.

6. Delta T and Wet Bulb Temperature Calculation Data:

- Delta T (the difference between air temperature and dew point) is a critical parameter for spray operations, as it influences droplet evaporation and drift potential.
- Wet bulb temperature calculations are essential for applications such as forestry/wildfire risk assessment, greenhouse climate control, and livestock facility management.



SwarmFarm's Integration of Airmar's WeatherStation®

SwarmFarm, a leader in autonomous farming solutions, has deployed over 300 Airmar WeatherStation® instruments across numerous customer's fleet of SwarmBots since 2019. These instruments provide the real-time weather data necessary for autonomous spray operations, enabling SwarmFarm's customers to comply with environmental regulations and optimize spray applications.

Data Collection and Real-Time Decision Making

SwarmBots equipped with Airmar WeatherStation® instruments record the following data every 5 seconds during operation:

- **Temperature**
- **Delta T** (critical for spray drift management)
- **Wind speed and wind gust**
- **Wind direction**
- **GPS position**

This data is used to create an as-applied map with real-time weather conditions captured at the nozzle. Additionally, SwarmFarm has developed algorithms that use the moving vehicle's velocity and orientation to correct observed wind speed and direction, providing a more accurate static wind observation from a moving robot.

Autonomous Spray Control

SwarmFarm's SwarmView app allows operators to set weather constraints for each spray job based on chemical label instructions. The onboard weather station continuously monitors conditions against these limits. If conditions exceed the set thresholds (e.g., wind speed too high or Delta T too low), the SwarmBot automatically stops spraying. Once conditions return to acceptable ranges, spraying resumes automatically.

This real-time decision-making process ensures that spray operations are conducted within safe and effective parameters, reducing chemical drift and improving application efficacy.

Current Integration Method and Future Potential

Currently, SwarmFarm integrates the Airmar WeatherStation® instruments with its SwarmBots via a serial connection. While the new 300WX series offers CAN, J1939 and ISOBUS protocols, SwarmFarm's current serial integration meets its autonomy requirements. However, the potential for future adoption of these advanced communication protocols could further streamline system integration and data exchange.

Benefits and Impact on SwarmFarm's Customers

The integration of Airmar's WeatherStation® instruments has enabled SwarmFarm's customers to achieve significant benefits in their spray operations:

1. Regulatory Compliance:

- The real-time weather data recorded from the WeatherStation® instruments provides a robust record of conditions at the point of application, supporting compliance with APVMA label instructions and state-based spray record requirements.
- Farmers can confidently demonstrate that their spray operations were conducted within approved weather limits, reducing the risk of regulatory penalties.

2. Improved Spray Efficacy:

- Accurate Delta T and wet bulb temperature calculations help farmers optimize droplet size and reduce chemical drift, improving the efficacy of spray applications.
- Real-time wind measurements enable the SwarmBot to adjust spray parameters dynamically, ensuring that chemicals are applied under optimal conditions.

3. Operational Efficiency:

- Autonomous sprayers equipped with WeatherStation® instruments can operate continuously without human intervention, reducing labor costs and increasing operational efficiency.
- The “Snooze” mode feature allows SwarmBots to enter a low-power state during adverse conditions and resume operation when conditions improve, further enhancing efficiency.

4. Data-Driven Decision Making:

- The CAST™ app provides farmers with intuitive access to real-time weather data, enabling them to make informed decisions about spray operations.
- Customizable data display layouts allow users to visualize weather conditions in digital, graphical, or hybrid formats, tailored to their specific needs.

5. Scalability and Growth:

- With over 300 WeatherStation® instruments deployed in the field, SwarmFarm has demonstrated the scalability and reliability of its autonomous sprayer solutions.
- The company's continued growth in the Agtech market underscores the value of integrating high-precision weather data into autonomous farming systems.



Photo Courtesy of SwarmFarm

Future Outlook: Advancing Autonomous Agtech with Airmar

As SwarmFarm continues to expand its fleet of autonomous SwarmBots, the role of Airmar's WeatherStation® instruments will remain critical in driving innovation and efficiency in precision agriculture. Farmers have expressed interest in additional features that could further enhance the capabilities of these instruments, including:

- **Rain Detection:** To provide real-time alerts when precipitation begins, allowing for timely adjustments to spray operations. Airmar's current rain sensor (150WXRS) reports data for rain amount, duration and intensity but is intended for stationary installations only. Future development may make rain detection possible from a moving vehicle with a rain sensor.
- **Inversion Detection:** To identify atmospheric conditions that trap spray drift near the ground, improving safety and compliance.
- **Confidence Metrics:** A quality metric (e.g., standard deviation or uncertainty value) to indicate the reliability of weather observations, helping to identify situations where readings may be affected by vibration, turbulence, or mounting position.

Airmar's commitment to continuous improvement ensures that its WeatherStation® instruments will evolve to meet the growing demands of system integrators in the autonomous Agtech market. By providing accurate, reliable, and real-time weather data, Airmar is empowering farmers and Agtech companies like SwarmFarm to achieve higher precision, efficiency, and sustainability in modern agriculture.

Conclusion

The integration of Airmar's WeatherStation® instruments into SwarmFarm's autonomous SwarmBots exemplifies the power of precision agriculture technologies in modern farming. By providing real-time, accurate weather data, these instruments enable SwarmFarm's customers to comply with environmental regulations, optimize spray applications, and drive operational efficiency.

As the autonomous Agtech market continues to grow, the collaboration between Airmar and SwarmFarm serves as a model for how advanced sensor technologies can revolutionize farming practices. With ongoing innovation and a focus on customer needs, Airmar's WeatherStation® instruments will remain at the forefront of the autonomous agriculture revolution, helping farmers achieve higher yields, reduce environmental impact, and build a more sustainable future.



For more information about Airmar WeatherStations, please visit [AIRMAR.COM](https://www.airmar.com)
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