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# AGRICULTURAL WEATHER SOLUTION

## A BUYING GUIDE



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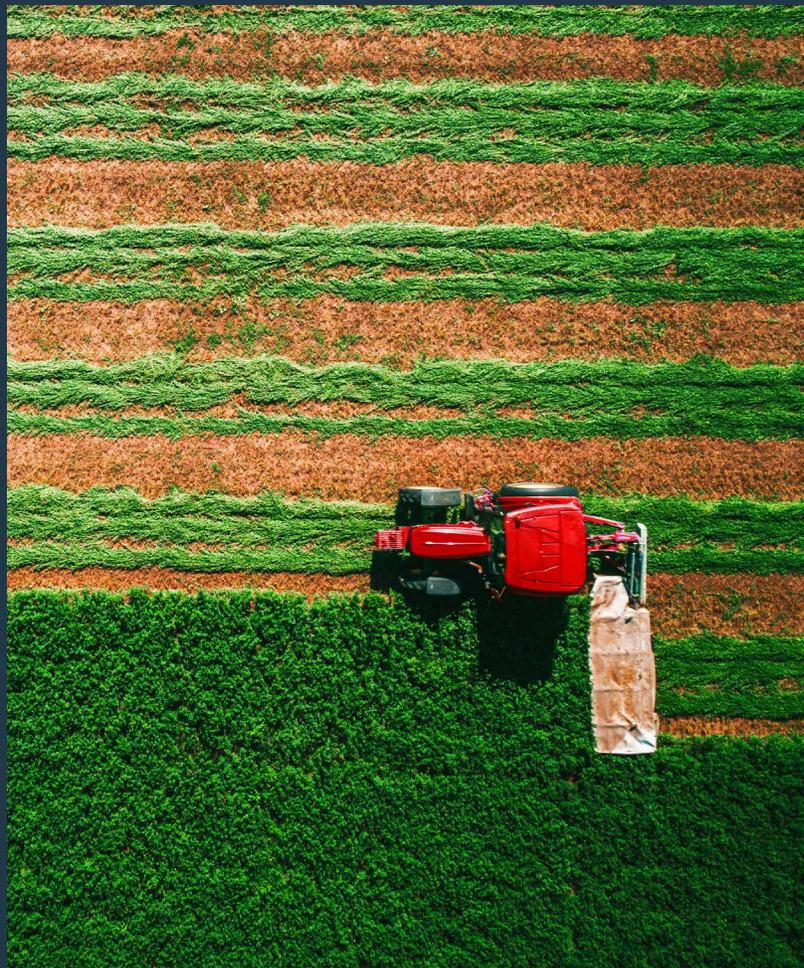
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# Introduction to Davis Instruments' EnviroMonitor system and Earth Networks Sferic Connect

In the age of smart farming, growing decisions must be data driven. There are too many variables, and a lot to lose. EnviroMonitor and Sferic Connect offer farmers large and small the ability to create a data inflow system that not only provides raw data, but converts that data into actionable information. The system is affordable, even for small growing operations where every penny must be wisely spent, and easy to install without the need to set up an on-site technical support team. The system was designed specifically for farmers, not technical masterminds nor engineers. We've made it easy to integrate sensors into your system, to add, relocate, upgrade, and tweak your sensor network as the seasons, crops, and needs change.

EnviroMonitor systems are composed of sensors installed in Nodes. The Nodes send the data via self-optimizing mesh network to a cellular or Wi-Fi Gateway. You choose the sensors (either Davis Instruments or any from a long and always growing list of trusted third-party manufacturers) and install them where you want them. The data you need will be delivered to your phone quickly, securely, and reliably.

Our sister company, Earth Networks, produces a mobile application made to keep farm teams and workers connected connected to real-time weather conditions. Sferic Connect is a severe weather hub that collects real-time weather data and sends alerts through mobile devices based on specific locations of employees. Customizable alerts are set by admins and push notification alerts come immediately.





## Weather and Agriculture

We don't know exactly when farming began, but a good guess is that farmers have been planting, weeding, watering, and protecting food crops for about 12,000 years. And every one of those farmers knew this: *it all starts with the weather.*

While some farming can be done inside in greenhouses, grow rooms, or poly tunnels, most crops are grown outside where crucial sunshine and water are provided by Mother Nature. Those gifts of nature come with the threats of not enough or too much, with freezes and heat waves, and damaging winds. These stresses can also promote pests and diseases.

Good or bad, weather always reigns supreme because the farmer has no power over it. They are left with only the power to take advantage of good weather and mitigate any damage caused by extreme weather.

# All growers need weather data

Weather drives the myriad decisions that must be made by growers. The weather parameters that most affect crops are temperature, humidity, precipitation, dew point, Evapotranspiration, and wind speed.

In addition to these basic weather parameters, growers need data from specific sensors in their fields such as soil moisture, flow meters, leaf wetness, pressure, tank/pond level, Carbon Dioxide, and even weight. Growers whose crops, like herbs and flowers, are grown in greenhouses or in grow rooms, need to know real-time greenhouse data such as temperature, humidity, soil moisture, CO<sub>2</sub>/O<sub>2</sub>, and light (solar radiation or PAR) from inside those greenhouses and grow rooms. Which sensor and where each sensor should be installed varies from one farm and crop to the next.

## Weather affects almost all of a farmer's daily decisions.

- When to plant and harvest
- Understanding crop growth cycles: Chilling Units and Growing Degree Days
- When to mitigate pests
- How to prevent diseases
- When to spray safely
- When to take steps to prevent frost damage
- How much and how long to irrigate
- How to keep workers safe from lightning, UV radiation exposure, and other weather



# Weather threats and impacts to growers

Farmers have to be gamblers: the most informed, analytical, experienced, and prepared kind of gambler. You must come armed with all the information you can to minimize the gambling part of the job: the inability to predict weather events. A sudden frost or heat wave can undo weeks of hard work, or even destroy a crop. Drought, high rain, high winds, pest infestation, and hail are a few

other weather events that must be forecasted and prepared for to prevent crop damage or loss.

This is why the first and usually most important part of any ag weather system is a reliable, rugged, accurate weather station like a Vantage Pro2 GroWeather. Along with the Mobilize app, your GroWeather will arm you with facts about:



# Frost

Frost is one of the most destructive forces of nature when it comes to farming. You need real-time weather data as well as long-term forecasts to determine when the danger of frost has passed each spring. A frost that hits in late spring or early fall can devastate a crop. It especially affects the soft, actively growing parts of plant, such as flower and vegetative buds. It can be benign if crops are “hardened” or if it is just frost on the surface of leaves that melts slowly. But when ice crystals form inside plant tissues they become miniature daggers that wreak havoc on plant cells by rupturing rigid cell walls. Frost after bud break can be detrimental to fruiting crops, causing them to drop their flowers and therefore lose potential fruit yield. Repeated freezing and thawing, or very rapid thawing can be particularly damaging.

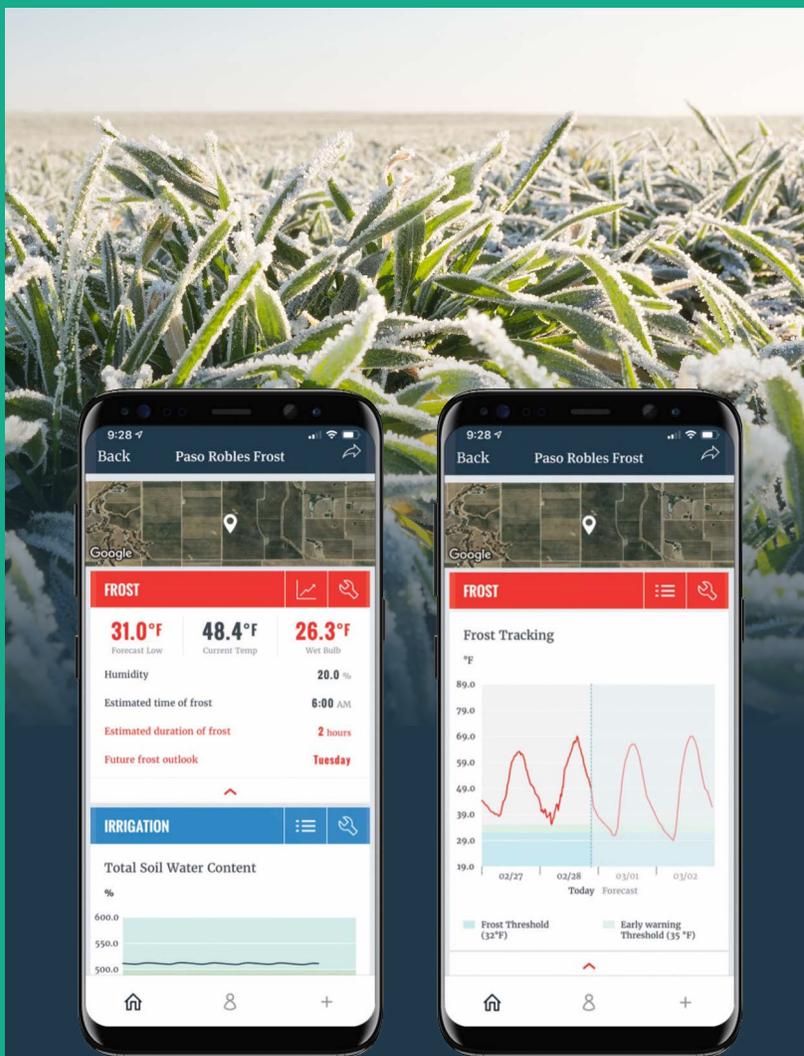
Frost injury usually happens via two different and distinct weather phenomena: radiation freeze or advective freeze.

Plants, like everything else, lose heat via radiation to the atmosphere. On a calm, clear night following a cold day, plants sometimes lose more heat than they receive. A low temperature inversion can form, with cold air near the ground trapped by warmer air above it. If the air temperature at the plant level is below, or even near, freezing, ice crystals can form inside the plant tissue. This is called a radiation freeze.

Freeze injury caused by advection occurs when an air mass with temperature below freezing moves in, displacing the warm air. The plant temperature drops too, and ice crystals form.

Either way, when low temperatures do damage plants, whether by frost or freeze, the damage looks the same. Plants become limp, blackened, and distorted. Frost can kill some plants outright; sometimes the damage, especially to stems, might not be evident for weeks or even months.

Knowing when a frost is coming can help you know when to turn on fans or sprinklers to protect your crops. Your GroWeather station, along with the Davis Mobilize and WeatherLink apps, can help you forecast frost and allow you to set alarms when temperature thresholds are reached that require action. This can be especially helpful in microclimates on a vineyard or orchard.



# Chill Accumulation

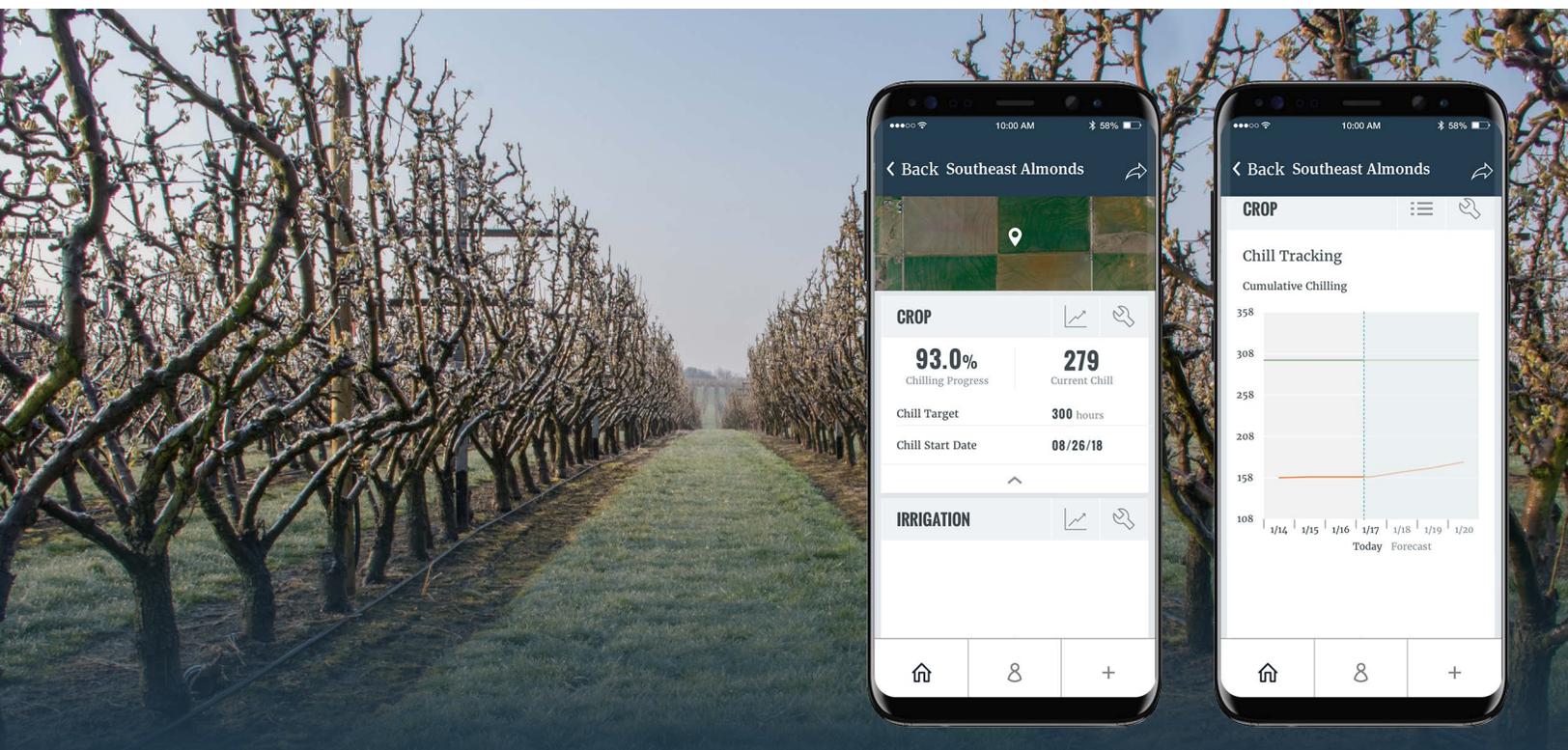
Stone fruit trees, and many other plants, face the threat of cold temperatures by settling in for a long winter's nap with two stages of dormancy. During the first stage, the process can be reversed if temperatures rise. During the second stage, the trees are in deep dormancy, and they are soaking up the chill, in packets of hours or units, called chilling accumulation. When chilling accumulation begins to decline and temperatures outside rise, the plants begin to wake up, grow, bud, and flower.

Depending on variety and species, if your crop does not get enough chill units, you may have to deal with problems of delayed foliation, bare shoots, and weakened trees; delayed or extended bloom; weak budbreak; and even flowers that just fall off, fruits that never develop, increased risk of pests and disease, or poor quality fruit.

Too much chilling can be problematic too. It can cause your plants to end their dormancy too soon and leave them exposed to damage from a late season freeze. It can produce a short bloom season and heavier fruit, which means more work to thin.

When your plants get their required chill hours, larger and healthier yields are often the result.

EnviroMonitor and the Mobilize app can track your crop's chill hours using temperature and humidity data from the Vantage Pro2 GroWeather, or from temperature/humidity sensors installed in EnviroMonitor Nodes. In the Mobilize app, you just choose your chill accumulation method, set the chilling target for your crop, set a chill start date, and start watching your crop's chilling progress.

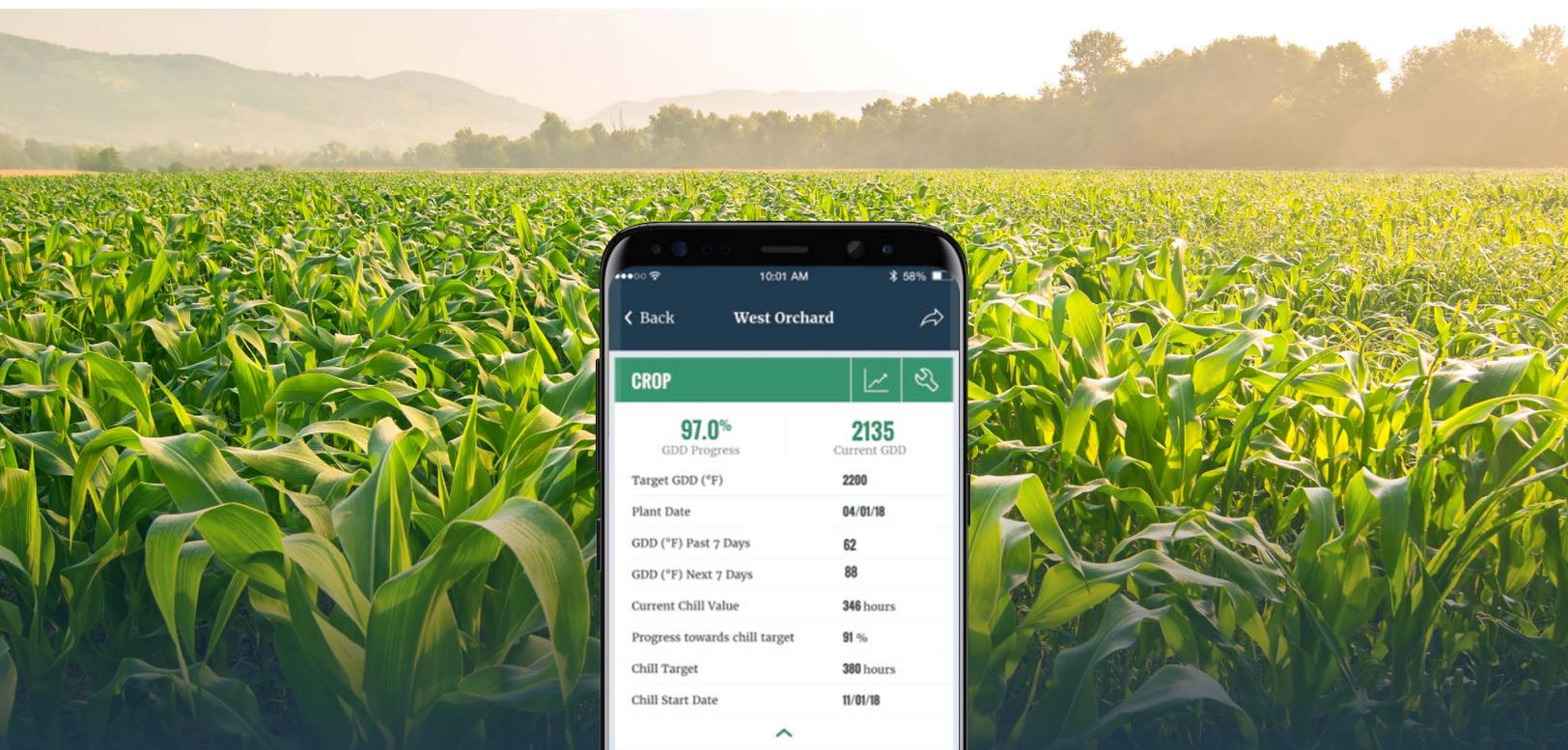


# Growing Degree Days (GDD)

GDD is crucial for tracking the growth cycle of your crop and knowing when harvest is approaching. Like insects, plants develop in stages – such as germination or flowering. The parameters that most affect these developmental stages are air temperature and the accumulation of heat. As the early spring sun warms the air, winter-sleepy plants start to accumulate heat. Some cool season plants like peas or alfalfa don't need a lot of heat, while others, like corn, need a lot. Unless the plant is stressed by drought or disease, when a specific accumulation has occurred the next stage will be reached. This accumulation is called Growing Degree Days, or GDD. A GDD is when the average daily temperature was above the plant's specific lower threshold, that point below which it is too cold for any development to happen.

Each crop has its own GDD threshold and each stage has its own GDD requirement. Some crops also have an upper threshold, over which either little or no development can happen, so the total must be adjusted for days when the temperature exceeds the upper threshold. GDD also affects the development of pests, so helps track pests and their life cycle.

To track GDDs, you need to know heat accumulation and your crop's specific heat needs. Mobilize App lets you set your crop, planting date, base threshold, and target GDD to give you and your team a truly actionable GDD report, right on your phone.



# Precipitation and Irrigation

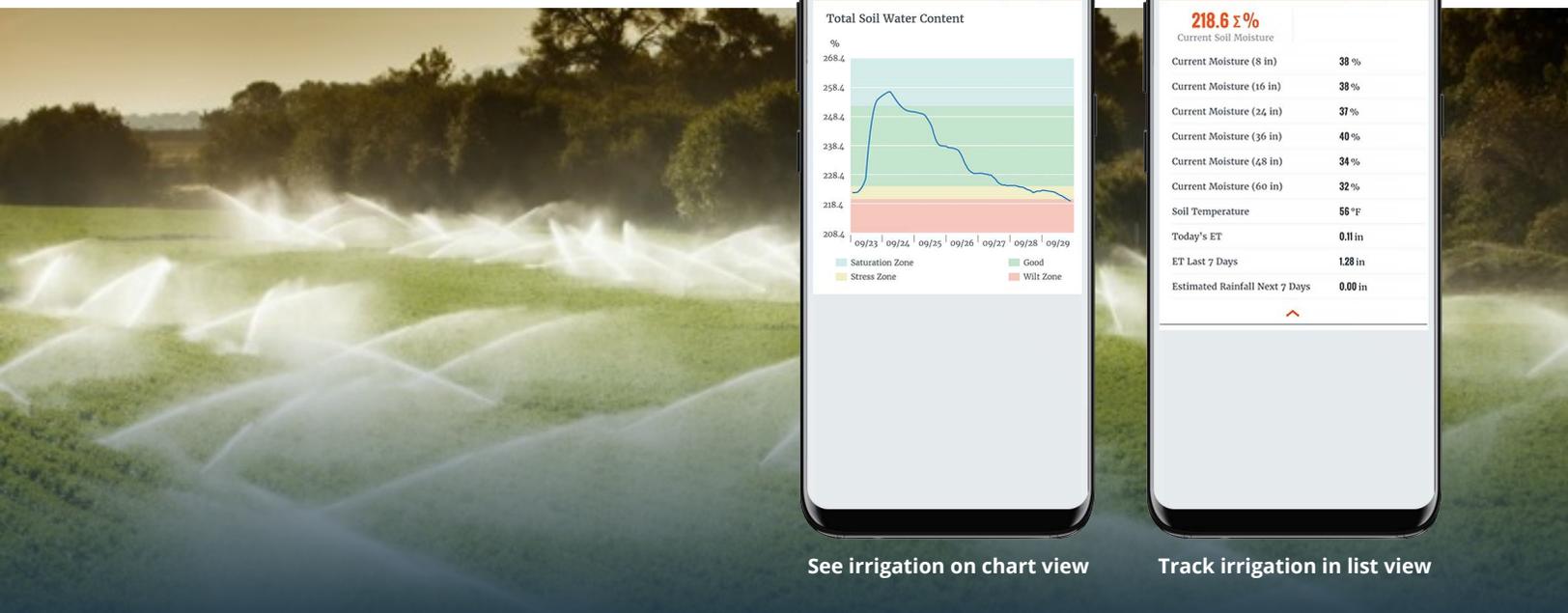
Plants need water to do their magic act of creating carbohydrates from sunlight. Farmers depend on rainfall to provide at least some of that water, as well as to charge the water tables and fill storage tanks. Water pumped onto thirsty plants is a resource that is increasingly limited and expensive for many growers and one that must be carefully managed.

Water is essential to plants, but too much or too little can mean doom.

Too much water can cause roots to rot and suffocate the plant by preventing oxygen absorption from the soil. Too much water encourages the growth of funguses and some plant diseases and drowns the microorganisms that are necessary to healthy soil. Excess water runs off plants and can take with it fertilizers and pesticides, wasting farmer resources and causing pollution of waterways.

Too little water, especially during growth stages can cause moisture stress that can kill plants or reduce yield. In corn, for example, moisture stress can lead to smaller ears and lower kernel and grain numbers.

Soil moisture monitoring is typically unavoidable, but as water become more limited or excessive, the importance of precision monitoring increases. EnviroMonitor and the Mobilize app, along with your own experience as a farmer, let you make decisions based on your specific crop and planting dates with easy-to-use irrigation/soil moisture reports based on data from your weather station and soil moisture probes installed in Nodes in your fields. You can also install flow meters to track how much water is being used, and pressure transducers to monitor irrigation sets or the health of your irrigation line.



See irrigation on chart view

218.6 ±%	
Current Soil Moisture	
Current Moisture (8 in)	38 %
Current Moisture (16 in)	38 %
Current Moisture (24 in)	37 %
Current Moisture (36 in)	40 %
Current Moisture (48 in)	34 %
Current Moisture (60 in)	32 %
Soil Temperature	56 °F
Today's ET	0.11 in
ET Last 7 Days	1.28 in
Estimated Rainfall Next 7 Days	0.00 in

Track irrigation in list view

# Heat and UV radiation

The safety of your team, especially those working in the field, is always a top priority for growers. Your weather station will provide you not only the outside temperature, but also the more useful Heat Index. An 85°F-day may seem to be safe for workers, but if the Heat Index on that day is 95°F, your workers will need to be protected from heat-related illness. You can also install a UV sensor on your GroWeather station to know when workers are at high risk for sunburn. With a UV sensor installed, either on your weather station or installed in an EnviroMonitor Node, you'll always know the risk.

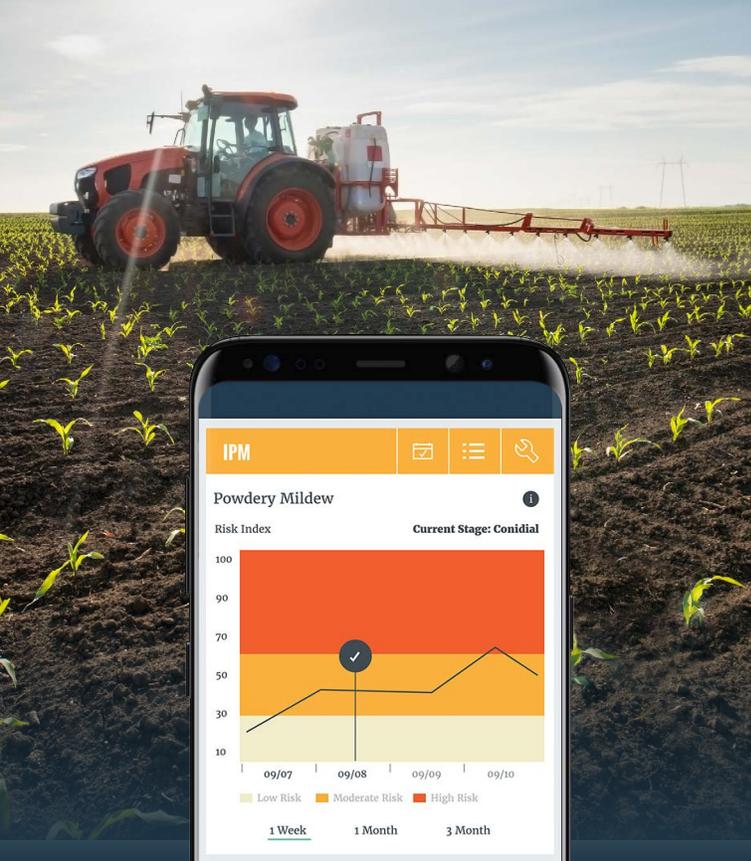


# Wind

High winds can directly damage plants by breaking branches and stalks. Young corn for example, can be flattened by high winds, especially during times of rapid growth. Even if not snapped, wind can flatten corn plants and cause "root lodging," a disruption of the root system and leaf orientation. Winds can break branches of fruit and nut trees, tear leaves off plants, abrade plant canopies, exacerbate ice accumulation, and remove layers of soil. Wind can cause turbulent mixing of the air and reduce air and soil temperatures, increase evaporation, and reduce humidity.

EnviroMonitor gives you the real-time wind data you need. You can use the GroWeather anemometer (either standard or sonic), mounted above your crop's canopy, or install a sonic anemometer in an EnviroMonitor Node wherever needed in your field, vineyard, or orchard.





# Pests

Pest and plant diseases, unlike the weather, are predictable because their growth cycles are highly determined by temperature, humidity, and ET. Models for specific plant pests, along with data from their weather station, let growers know when conditions are right to promote pests in time to take steps to prevent damage.

The Vantage Pro2 GroWeather comes with a solar radiation sensor installed so that you system can report ET values. This allows you to choose crop and pest models in the Mobilize app, so you are one step ahead of the creatures and diseases that can harm your crop.



# Humidity

Growers whose plants are in greenhouses don't need to be as concerned with wind and frost as those whose crops are outside. But they do need to be even more concerned with humidity. Humidity is not easy to control in greenhouses, but vents and fans are tools farmers can use if they are aware of the fluctuations of humidity. If not controlled, high humidity can contribute to foliage and root diseases, nutrient deficiencies, and plant stress; low humidity can cause wilting, slow growth and cause leaves to curl or drop. Humidity must be kept below the dew point, but not allowed to fall so low that plants lose too much water and wilt.

With an EnviroMonitor system, you can install humidity sensors where they are needed. The Nodes will push the data to the WeatherLink cloud platform so you'll know when to open vents or start your fans.

# Lightning

Farming does not stop when bad weather threatens. But the production of essential crops must start with the safety of your team. Lightning not only poses a huge threat to anyone outside during a thunderstorm, but even before and after it has passed. The skies may look clear, but that doesn't mean lightning isn't in the area. Lightning happens fast, so knowing when dangerous conditions exist before it strikes will enhance the safety of your team.

Sferic Connect allows you to track the radar for incoming storms and see where lightning is striking the area in real-time. Weather parameter alert triggers can be set by the admins, and if dangerous conditions are present, employees will be alerted based on their mobile device location. This is especially important to individuals working in remote fields who need to be able to access real-time weather conditions and lightning threats in their area.



# Creating the perfect AG Weather System

The perfect agricultural weather system will be specific to the conditions and plants in your field, vineyard, or orchard. To build the perfect agricultural weather system, you will need to consider your fields, your crop, your growing season, and your irrigation choices.

## ***What are your weather risks?***

Know the threat to your crops from frost, wind, drought, flood, high humidity, ice, rain, heat, and pests. Consider the dangers of UV, heat, and lightning for your workers.

## ***What data do you need for your specific crop(s), your specific soils, and your specific equipment?***

Do you need to know growing degree days and chilling hours? Do you need to control wasted water and other resources? Are your crops grown in greenhouses or grow rooms?

## ***What sensors do you need to start your system?***

A system that is easy to expand as needs change lets you start out small and build up.

## ***Where and who will install your system?***

Plan or map out your fields. Decide what sensors are needed where. EnviroMonitor installation is easy - you don't need heavy equipment and a degree in computer technology or engineering. Maintenance should be easy and intuitive.

## ***What communication choices are available?***

Does your field or greenhouse have Wi-Fi nearby? Or is it in a remote location where communication must be cellular?

## ***Who needs to know when extremes threaten?***

You and your team will need to be alerted in time to take steps to mitigate damage and make timely decisions.

## ***What is your budget?***

Affordability is important. While a good system can prevent the loss of thousands of dollars, it must still remain within the grower's budget.

Once you have outlined these considerations, it's time to start creating your system. Here are the steps to design the perfect EnviroMonitor system for your farm.



### 1. Choose your communication method.

Your weather station and sensors will gather data and upload it for your access via either Wi-Fi or Cellular communication. Choose either:

- EnviroMonitor IP Gateway (if Wi-Fi is an option) (AC-powered) p/n 6805 or
- Cellular EnviroMonitor Gateway, (solar-powered) p/n 6802A and can be in its own line? You need it for either/both of the Gateways
- An annual service plan



### 2. Choose your weather station.

Your weather station will provide you with a vast amount of vital information. The sensor suite will send data packets every 2.5 seconds to the Gateway, which will then upload it to your WeatherLink.com page and the WeatherLink app.

#### Choose:

- Wireless Vantage Pro2 GroWeather (with Solar Radiation) (p/n 6820) (wireless sensor suites are compatible with IP Gateway only)
- Wireless Vantage Pro2 Plus (with Solar and UV Radiation sensors) (p/n 6327) (wireless sensor suites are compatible with IP Gateway only)
- Cabled Vantage Pro2 GroWeather (with Solar Radiation) (p/n 6820C)
- Cabled Vantage Pro2 Plus (with Solar and UV Radiation sensors) (p/n 6327C)

#### The sensor suite tracks:

- Outside temperature
- Outside humidity
- Rain rate and accumulation
- Wind speed and direction
- Dew point
- Heat index
- Barometric pressure (tracked by the Gateway)
- Solar radiation to track ET
- More



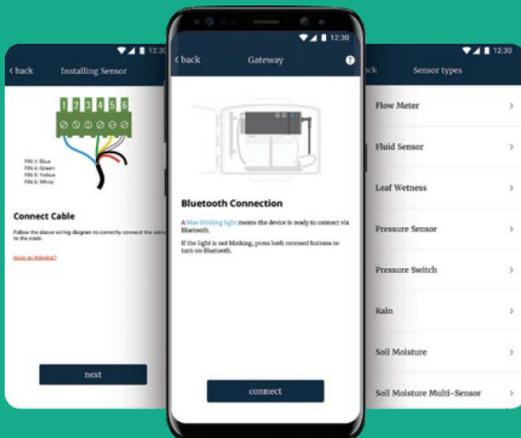
### 3. Add sensors to your system.

Now you can expand and customize your agricultural weather system by adding the sensors you need, where you need them.

Choose the sensors you need from a growing list of Davis and trusted third-party sensors. Install the sensors in EnviroMonitor Nodes. Each Node can support up to four sensors. The solar-powered Node sends the sensor data to the Gateway over a self-optimizing mesh network. Each Gateway can “listen” to up to 32 Nodes. The powerful solar panel and backup battery mean no missed data. Nodes can also receive and repeat data from nearby Nodes, allowing you to create a true mesh network.

**The long and always-growing list of sensors compatible with EnviroMonitor includes:**

- Leaf Wetness
- Rainfall
- Soil Moisture
- Solar Radiation
- Temperature
- Temp/Humidity
- Wind
- Carbon Dioxide
- Flow Meter
- Level Sensor
- PAR (PPFD)
- Pressure Transducer
- Pressure Switch
- Weight



### 4. Install your system app.

The EnviroMonitor App makes installation easy and intuitive. It walks you through each step on your phone. The EnviroMonitor app is the quickest and easiest installation process on the market.

# Accessing your data

Now that data is flowing, you will need to access it for analysis, comparison, alerts, and action.



## WeatherLink

Your farm's data will be uploaded to your account on WeatherLink.com and the WeatherLink app. You will have instant access to your real-time data on your phone, tablet, or computer.

WeatherLink.com allows you to set alerts so you, and anyone you select, will be notified via email or text when readings surpass a threshold you set. For example, when temperature and dew point indicate the possibility of a frost event, or when winds reach a high speed.

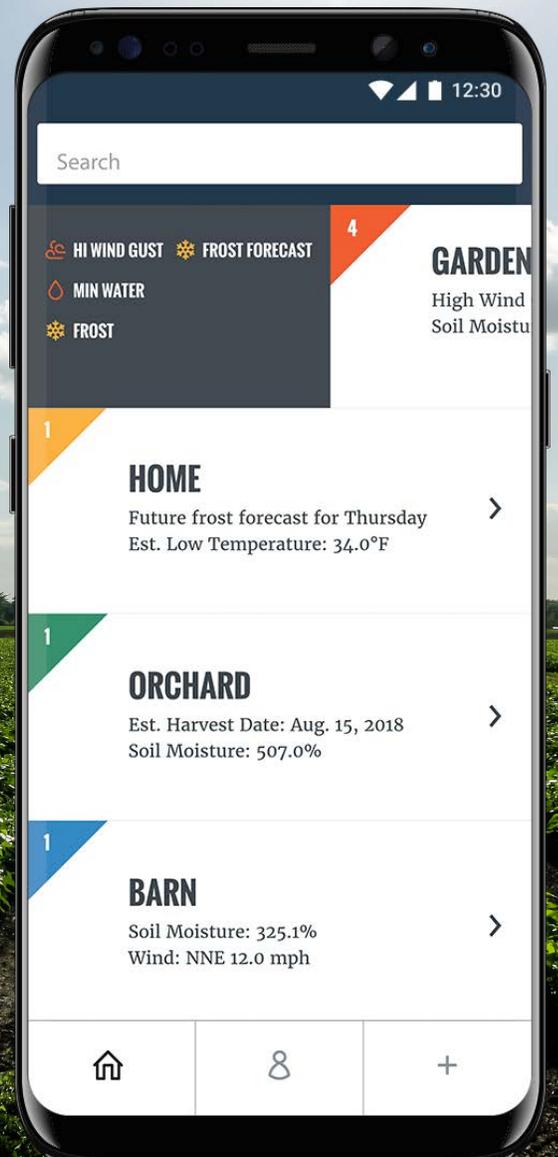
The customizable WeatherLink.com dashboard shows all your data in accessible tiles. Or see your raw data as it arrives from your sensors. You can also graph parameters, and access your historical data for analysis, share your data, see and track GDD, Chill, and more.

The WeatherLink app delivers your data to your phone, 24/7, for quick reference.

## Mobilize app

The Mobilize app is Davis Instruments' agricultural-focused app that turns your EnviroMonitor system into decision-making intelligence.

- Set up "views" of each of your fields or orchards, then see a snapshot of each view on one page. Color-coded flags alert you immediately to conditions that require your attention. Click on a view to dive into the data.
- See current conditions and reliable forecasts
- Access reports for frost, weather, crop, irrigation, and pest.
- Use real-time data to make informed decisions:
  - Time of frost
  - Frost forecast
  - Wind direction/speed
  - Today's rain
  - GDD forecast
  - Progress to chill target
  - Soil moisture levels
  - Today's ET
- Visualize the past and future with custom charts
- Predict future frost conditions
- Track daily temps
- Monitor rain events
- Monitor plant growth with chill and GDD
- Manage irrigation efficiently
- Create custom reports with specific sensors
- Define field targets and alarm thresholds to help make well informed decisions
- Easily share data with your team to collaborate on field intelligence





# Conclusion

Weather will always reign supreme in the world of farming. But with an EnviroMonitor system, you will have the data you need to make critical field decisions. You'll base decisions on data: accurate, reliable data from sensors you need in your own fields.

With EnviroMonitor, you can join the new age of Smart Farming with a system that is easy to use, easy to install, reliable, affordable, and customizable.