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AE502

Your Farm Weather Station: Installation and Maintenance Guidelines[1]

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Introduction

Weather is a prominent factor in the success or failure of agricultural enterprises. With the advent of improved and less expensive technology, many farmers are installing farm-based weather stations to track weather conditions, schedule irrigation, make decisions related to cold protection, and accomplish other tasks.

Although installation of a weather station provides farmers with a unique opportunity to better understand how weather interacts with their crops and livestock, conclusions and decisions must be based on high-quality observations. High-quality weather observations require (1) sensors that meet accepted minimum accuracy standards, (2) proper siting of the station, and (3) good maintenance. This publication intends to provide farmers with basic guidelines for installing and maintaining a weather station.

Purchasing a Station with Accurate Sensors

Before selecting and purchasing a weather station, some important questions must be answered. For example, what is the purpose of the weather station and which weather variables are important? It is important to consider observational range and accuracy of the sensors.

If interested in only tracking rainfall, a good quality rain gauge such as the one used by the Community Collaborative Rain, Hail & Snow project, or CoCoRaHS (http://www.cocorahs.org/), would be adequate—CoCoRaHS teaches users how to manually measure daily rainfall and then submit the observations to their website. If the main concern is cold protection, then air temperature and other variables such as relative humidity and wet bulb temperature are critical. If scheduling irrigation is important, estimating reference evapotranspiration (ET_o) is necessary,

Figure 1. ET107 model weather station
Credits: Campbell Scientific

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and it requires a larger set of variables, including solar radiation, wind speed, relative humidity, and air temperature. Similarly, certain plant-disease risk models use leaf wetness duration, which requires a specific sensor.

Manufacturers offer stations equipped with sensors that have varying observational ranges and accuracy. For example, relative humidity (RH) sensors can output different levels of accuracy depending on their observational range, with the typical accuracy for a medium cost weather station sensor being ±3% below 90% RH, and ±4%–5% above 90% RH. Lower accuracy for readings above 90% RH can be a problem if RH is being used to estimate leaf wetness duration for use in a mathematical model. On the other hand, the typical accuracy of air temperature sensors on a medium cost weather station is ±1°F across their entire observational range. Therefore, it is important to purchase sensors with the observational range and accuracy that will best support the desired application (e.g., cold protection, irrigation scheduling, and modeling).

Figure 2. Manual rain gauge from the Community Collaborative Rain, Hail & Snow Network (CoCoRAHS)
Credits: CoCoRAHS

Proper Siting of the Station

Selecting an appropriate site for your weather station is critical to obtaining useful weather observations. The site should be representative of the area of interest. For agricultural applications, the station should be located in a place that best represents field conditions. Stations located at airports or in urban environments are not appropriate for agricultural applications due to the high spatial variability of rainfall and the influence of built environments on temperature. Stations should be sited in order to minimize the influence that obstructions, such as buildings and trees, can have on observations. Perfect siting is not always possible but, depending on the application and sensors installed, the following rules should be observed:

a. *Wind speed and direction*: Wind sensors should be located over open, level terrain as far away from any nearby obstructions (e.g., buildings, trees) as possible—ideally a distance equal to 10 times the height of the closest obstruction.

b. *Temperature and relative humidity*: Temperature and relative humidity sensors should be located over an open, level area at least 10 m (about 30 ft) in diameter. The surface should be covered with short grass or another natural surface. These sensors should be located a distance of at least 4 times the height of any nearby obstruction, or at least 30 m (about 100 ft), from large paved areas. Sensors should be protected (or shielded) from thermal radiation and ventilated. Rooftops, steep slopes, high vegetation, shaded areas, swamps, low places that hold standing water after rains, and large industrial heat sources should be avoided.

c. *Solar radiation*: In the Northern Hemisphere, sensors should be mounted on the southernmost side of the station to prevent exposure to shadows. Reflective surfaces and artificial radiation sources should be avoided. Ensure tall trees and/or other structures will not shade the sensor as the angle of the sun changes throughout the year.

d. *Soil moisture and temperature*: Soil moisture/temperature should be measured in an area at least 1 m^2 (about 10 ft^2) that represents the soils in the fields of interest. The sensors should be installed at least 1.5 m (about 5 feet) from any tower or structure and away from areas where natural drainage from surrounding areas occurs. Soil temperature and moisture can be observed at different depths in the soil, but temperature is typically observed at 10 cm (4 in) below the surface, and moisture is typically observed at various depths, depending on the application of the measurement. If temperature is measured at a single depth, a depth that best represents root zone conditions is recommended.

e. *Rain gauge*: Rain gauges should placed as far away from obstructions as possible, ideally a distance equal to four times the height of the closest obstruction. The

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collector of the rain gauge must be in a horizontal plane, level, open to the sky, and above the height at which splashing rain and snow accumulation can influence the measurement.

f. *Leaf wetness*: Leaf wetness sensors should be installed at a height of 30 cm, facing north in the Northern Hemisphere (south in the Southern Hemisphere) at a 45° angle to the ground. The surface of the ground should be covered with short grass. The sensor should be placed in a location that is not affected by irrigation sprinklers or other sources of moisture.

Table 1 summarizes the above recommendations for agro-meteorological stations (which may differ from recommendations of the World Meteorological Organization and other agencies).

Local Maintenance Guidelines

It is common to find problems with data observed at weather stations that are not properly maintained—the only thing worse than no data is wrong data. Data clean-up may cost more than simply keeping a weather station in good working condition. Table 2 summarizes maintenance tips for the various sensors.

The power supply of the weather station should be checked regularly. Rechargeable power supplies should be connected to an AC power source to serve as a backup when the power supply fails. A solar panel can provide power to weather stations located away from AC power to operate the station during the day and charge a battery for nighttime operation. An occasional cleaning of the glass on the solar panel will improve its efficiency. Use warm, mildly soapy water and a clean cloth, and then rinse with clean water.

Weather data has many applications. Accurately scheduling irrigation and/or cold protection, for example, is very difficult, if not impossible, without reliable weather data. Proper maintenance of a weather station is imperative and will ensure the station is collecting data that is useful across many applications.

Conclusion

In summary, although installing a weather station provides farmers with a unique opportunity to better understand how weather interacts with their crops and their livestock, the proper selection of station and sensors, siting of the station, and regular maintenance are extremely important for the successful use of weather information in agricultural enterprises.

Figure 3. Most common problem found in rain gauges is clogging of the catchment funnel by insects, turf clippings, and dirt. Check weekly or more often if necessary.
Credits: C. Fraisse

References

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Table 1. Agro-meteorological station recommendations

Sensor Type	Measurement height or depth	Exposure considerations
Wind	2 m (about 6.5 ft); NOAA recommends 10 m	As far away from obstructions as possible—a distance equal to at least 10 times the obstruction's height.
Temperature and relative humidity	2 m (about 6.5 ft)	Housed in a ventilated shield to protect the sensor from external radiation, away from obstructions/pavement—a distance equal to at least four times the obstruction's height, and at least 30 m from large paved areas or water reservoirs.
Solar radiation	3 m (10 ft) or less	As far away as possible from objects that might shade the sensor.
Soil moisture and temperature	10 cm (4 in) below surface for temperature	1 m^2 level (over a 10 m radius) observation site that represents the surface of interest.
Rain gauge	1 m (about 3 ft)	As far away from obstructions as possible—a distance equal to at least four times the height of the closest obstruction. The collector must be in a horizontal plane, level, open to the sky, and above the level of possible splashing.
Leaf wetness	30 cm (1 foot)	Should face north in the Northern Hemisphere (south in the Southern Hemisphere) at a 45° angle to the ground.
Source: Adapted from Campbell Scientific (2015)		

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Table 2. Weather station maintenance

Sensor	Local maintenance tips
Solar radiation *Inspection frequency:* Weekly	One of the most important sensors to maintain, because solar radiation is a key parameter for calculating ET and irrigation scheduling. It must be kept clean and leveled. The small white sensing surface or the glass dome (for thermopile pyranometers) must be kept free of dirt, dust, debris, and bird droppings. A weekly examination of the sensor should be adequate for most locations. Debris should be removed from the top of the sensor, and then the white circle should be wiped with a damp cloth. Silicon cell pyranometers located near irrigation may exhibit an accumulation of salt over time. These salts may be removed using a cloth saturated with vinegar or some other weak acid. While cleaning the sensor, examine the bull's-eye level on the mounting plate to ensure the sensor is level (i.e., facing directly toward the sky). An off-level sensor can be brought into compliance by adjusting the leveling screws on the mounting plate. A screwdriver or hex key wrench may be required to adjust the level.
Rain gauge *Inspection frequency:* Weekly	Rain gauge maintenance involves keeping the gauge level and the collection funnel clean. The level may be checked with a carpenter's level placed across the opening of the collection funnel (many tipping-bucket rain gauges have a built-in level). If the gauge is not level, some adjustment may be necessary. Insects, turf clippings, and dirt can occasionally plug the funnel and prevent rainwater from reaching the recording mechanism. The funnel can be removed if extensive cleaning is necessary. Once the funnel is removed, the collection mechanism is visible. Dirt and debris should be cleaned from this area if required. Dirt (soil) is heavier than water and can cause mechanisms to record before the proper amount of water has entered the collection funnel. If this dirt is attached to the bottom of the bucket and does not wash out with the first few volumes of rainwater, the gauge may overestimate precipitation. The funnel should be replaced after everything is cleaned, ensuring it is level and seated against the base of the gauge. Once cleaned, a small amount of water should be poured into the funnel to ensure the recording mechanism works. For example, a tipping mechanism can become stuck by bad bearings, so it should be checked with water to ensure proper operation.
Temperature & Relative Humidity *Inspection frequency:* Monthly	Actual maintenance of the temperature and humidity sensors should be left to skilled technicians. However, local personnel can extend the longevity of these sensors by regularly removing accumulated dirt and debris from the radiation shield. The radiation shield sheds rainwater reasonably well but affords little protection against water arriving at an angle from ground level. Sprinklers should be adjusted to minimize direct water contact.
Wind speed *Inspection frequency:* Quarterly	The presence of observation is the primary indicator of a functioning anemometer. Problems are most apparent when winds are light—usually in the morning. Cups should be carefully cleaned using an index finger and a damp cloth, cleaning inside and around the cups. The main problem causing poor anemometer performance is dirt in and around the sensor bearings. An anemometer that emits a grinding sound, does not rotate at low wind speeds, or halts abruptly with a lull in the wind likely has bad bearings. Faulty bearings will generate erroneously low wind speeds and should be replaced as soon as possible. Bearing replacement is best performed by a trained technician.
Leaf wetness *Inspection frequency:* Weekly	Leaf wetness sensors must be kept free of sprinkler mist, dirt, dust, debris, and bird droppings. A weekly examination of the sensor should be adequate for most locations.
Source: Adapted from Brown and Russell (2010)	