# FEASIBILITY STUDY OF THE S5-E200 SENSOR FOR EVAPOTRANSPIRATION MONITORING IN CLASS A EVAPORATION PANS

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**Abstract**
This study evaluates the feasibility of the commercial sensor S5-E200 as an alternative to the traditional micrometric screw used in Class A evaporation pans for estimating reference evapotranspiration (ETo). Commonly employed in fuel tanks, the sensor was coupled to an Arduino microcontroller and subjected to controlled experimental tests. Four repetitions were conducted, with measurements taken at every 1 mm variation in water level, totalling 171 distinct levels and 684 readings per treatment. The data were organized in spreadsheets and analyzed statistically, calculating the arithmetic mean and standard deviation for each level. Results showed that although the sensor was capable of detecting changes in water column height, it lacked the sensitivity required to detect precise 1 mm variations—an essential criterion for reliable ETo estimation. The treatment using a digital multimeter demonstrated greater stability, with an average standard deviation of 0.05 ohms, while the automated Arduino system exhibited higher variability, with an average standard deviation of 8.5 ohms. This fluctuation is attributed to the indirect method of resistance calculation, based on voltage readings and an external resistor. It is concluded that the S5-E200 sensor is not suitable for direct replacement in Class A pans but may be useful in less demanding water monitoring systems, such as reservoir management or low-complexity irrigation, provided it is properly calibrated and adapted to specific operating conditions.

**Keywords:** Arduino, Measurement Automation, Low-Cost Sensor, Agricultural Instrumentation, Class A Evaporation Pan

## INTRODUCTION

The Class A evaporation pan is a standardized instrument developed by the United States Weather Bureau (USWB) and recognized by the FAO as an international reference for evapotranspiration estimates. This parameter represents the loss of water through evaporation and transpiration from an idealized vegetative surface under favorable atmospheric conditions, and is essential for determining the water requirements of agricultural crops. Reference evapotranspiration (ETo) is widely used in the calculation of irrigation depth, directly influencing plant productivity and the conservation of water resources (Allen et al., 1998).

Evaporation measurement in the Class A pan is traditionally performed using a micrometric screw installed in a stilling well. This instrument offers high precision, capable of detecting millimeter variations in water level. Considering that each millimeter of evapotranspired water corresponds to approximately 1 liter per square meter, any reading error can compromise the ETo estimate, leading to incorrect irrigation decisions and potential agronomic losses (Pellison, 2018).

Despite the precision of the micrometric screw, its operation requires daily manual measurements at fixed times, making it susceptible to operational failures. Inaccurate readings, timing inconsistencies, and handling variability are factors that affect data reliability. These accumulated errors may result in over- or under-irrigation, harming plant physiological development and reducing water use efficiency (Schwingel et al., 2001).

Given these limitations, this study proposes replacing the micrometric screw with a commercial level sensor, the S5-E200, illustrated in Figure 1, which is commonly used in industrial tanks for fuel monitoring. Integrated with an Arduino microcontroller, the system aims to automate data collection, minimize human interference, and ensure greater measurement accuracy. The proposal seeks to validate the technical feasibility of the sensor for use in Class A pans, contributing to the modernization of water management in agriculture.

Figure 1. S5-E200 Sensor.

Source: Promportal, 2025.

**MATERIALS AND METHODS**

To simulate the evapotranspiration environment of the Class A evaporation pan, a glass graduated cylinder with a maximum capacity of 500 mL was used. A millimeter-scale measuring tape was externally affixed to the cylinder to allow precise verification of the water level. The sensor employed in the experiment is a commercial type, commonly used for level measurement in fuel tanks. It consists of a metallic rod equipped with a floating buoy, whose position along the rod alters the electrical resistance of the circuit, enabling the identification of the water column height through ohmic variation, according to the manufacturer's manual (Wema, 2025).

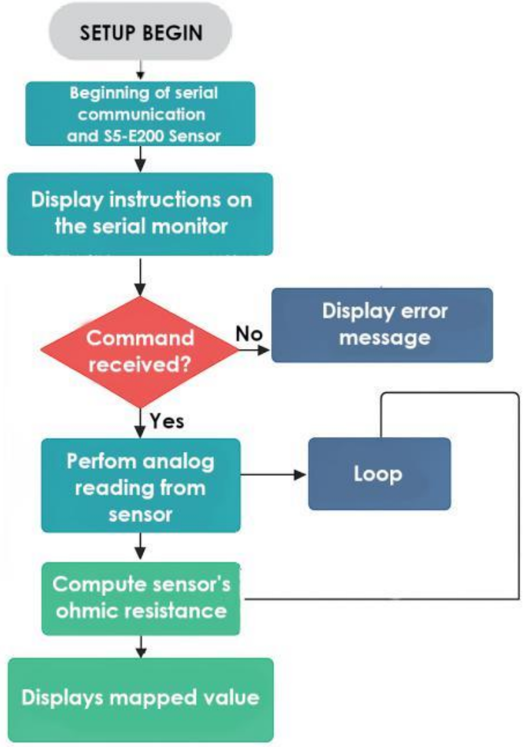
The sensor was vertically inserted into the cylinder, with its maximum height aligned to the zero point of the measuring tape, as illustrated in Figure 2. To simulate evapotranspiration, water was gradually withdrawn using a syringe connected to a silicone hose, allowing precise control of the removal process. For each 1 mm variation in water level, as indicated by the measuring tape, the withdrawn volume was transferred to a 15 mL Falcon tube, enabling verification of the correspondence between height and volume and ensuring standardized withdrawals.

Figure 2. Experimental setup of the S5-E200 sensor.

Source: Developed by the authors, 2025.

The experiment was divided into two distinct treatments. In the first, a digital multimeter was connected in series to the sensor terminals, forming a simple electrical circuit. In the second, an algorithm was developed in the Arduino IDE environment, as shown in Figure 3, to automate data collection by converting electrical resistance into digital values corresponding to the height of the water column. In both treatments, four independent tests were conducted, starting at 0 mm and ending at 170 mm, totalling 171 distinct height levels per test.

Figure 3. Programming logic diagram for the S5-E200 sensor.



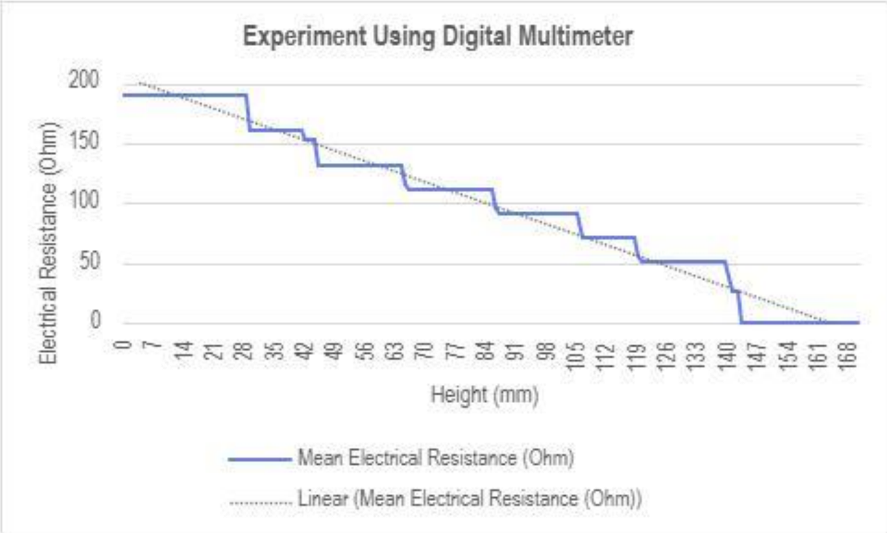

**Source:** Developed by the authors, 2025.

For each level, corresponding to a 1 mm variation, the ohmic resistance value obtained from both the multimeter and the Arduino was recorded in an Excel spreadsheet. The data were then subjected to arithmetic averaging per level across the four tests, along with standard deviation calculations, allowing for an evaluation of the consistency of the readings and the sensor's sensitivity. This procedure enabled the validation of the commercial sensor's feasibility as an alternative to the traditional micrometric screw, considering the millimeter precision required for reliable reference evapotranspiration (ETo) estimates.

## RESULTS AND DISCUSSION

The analysis of the arithmetic means obtained from the four tests conducted for each treatment revealed distinct behaviors between the reading methods. In the treatment using a digital multimeter, the mean values remained constant across height blocks, with discrete transitions at specific points, as illustrated in Figure 4. This pattern indicates that the sensor responded consistently to changes in water level, although perceptible variations occurred only after a certain accumulated displacement of the float. Such behavior suggests low sensitivity to 1 mm variations in certain segments, but reinforces the reliability of the manual method for point-specific measurements.

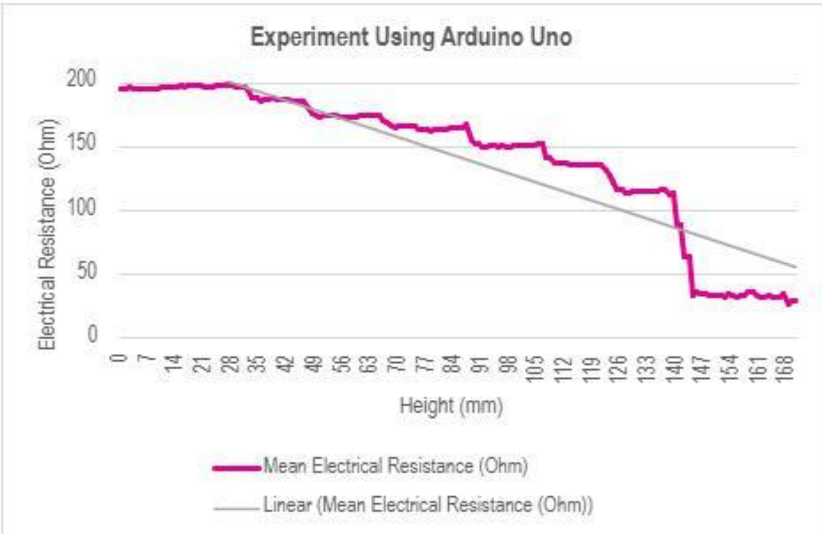
Figure 4. Arithmetic mean of the data obtained from 0 to 170 mm in the digital multimeter treatment.




Source: Developed by the authors, 2025.

On the other hand, Figure 5 shows that the Arduino-based treatment exhibited a continuous progression of mean values across the 171 analyzed levels, demonstrating that the automated system was capable of capturing the gradual variation in electrical resistance according to the height of the water column. Despite the greater dispersion observed, the overall trend of the mean values consistently mirrored the behavior recorded by the multimeter, indicating that the sensor may be functional in automated applications, provided it is properly calibrated.

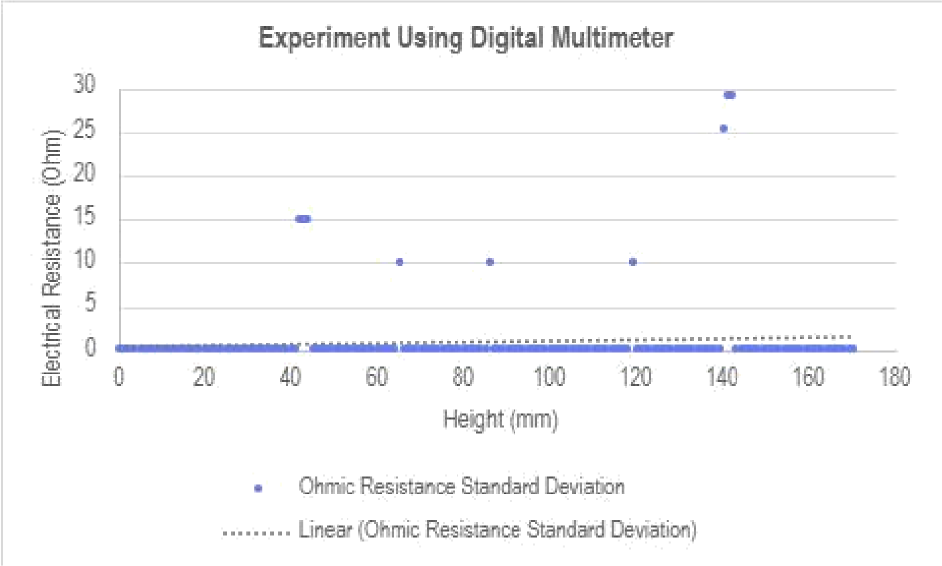
Figure 5. Arithmetic mean of the data obtained from 0 to 170 mm in the Arduino Uno treatment.




Source: Developed by the authors, 2025.

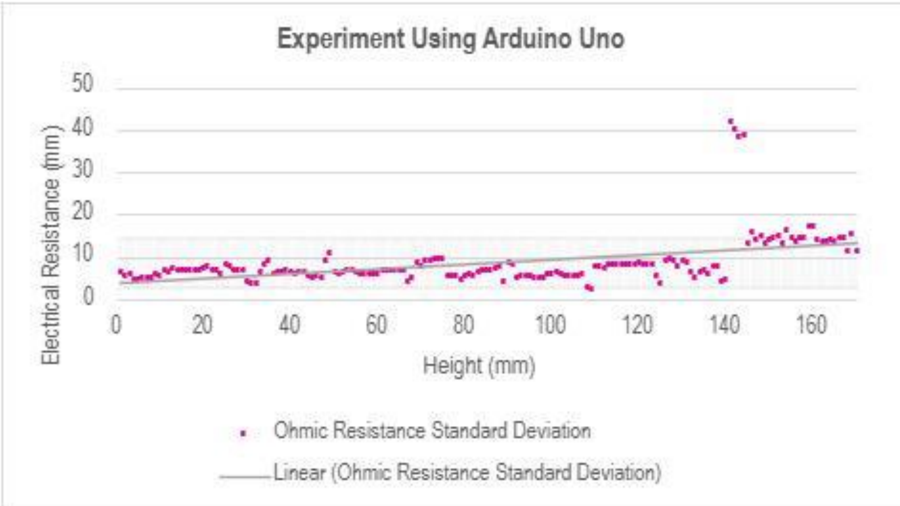
Regarding the standard deviation, illustrated in Figures 6 and 7, the multimeter showed an average value of only 0.05 ohms, demonstrating high consistency across tests and excellent stability in the readings. The trend line remained virtually constant throughout the entire scale, with minimal variations. In contrast, the Arduino presented an average standard deviation of 8.5 ohms, with more pronounced fluctuations, especially at lower levels. This oscillation can be attributed to the indirect method of calculating electrical resistance: the Arduino reads the voltage in the circuit and, with the aid of an external resistor, estimates the resistance using Ohm's Law. This approach is subject to signal noise, voltage variations, and limitations of the analog-to-digital converter, which may compromise the point-by-point accuracy of the measurements.

Figure 6. Standard deviation of the data obtained from 0 to 170 mm in the digital multimeter treatment.




Source: Developed by the authors, 2025.

Figure 7. Standard deviation of the data obtained from 0 to 170 mm in the Arduino Uno treatment.




Source: Developed by the authors, 2025.

Although the multimeter stands out for its precision in point-specific measurements, the Arduino represents a viable alternative for automating data collection. With algorithm adjustments, the use of higher-precision components, and proper calibration, it is possible to reduce signal fluctuation and enhance the reliability of the automated system, contributing to the modernization of water management in agriculture.

Although the S5-E200 sensor demonstrated the ability to detect variations in the height of the water column throughout the tests, the results indicate that it is not ideal for replacing the traditional micrometric screw used in Class A evaporation pans. The main limitation observed was its inability to detect precise 1 mm variations — a fundamental requirement for reliable reference evapotranspiration (ETo) estimates. In several segments of the scale, the sensor exhibited discrete responses or abrupt jumps, leaving gaps between recorded levels and compromising the millimetric resolution required for high-precision agricultural applications.

This limitation stems from both the float's mechanical design and the method of reading electrical resistance, especially in the Arduino-based system, where resistance is calculated indirectly from voltage readings and an external resistor. As a result, the sensor does not meet the sensitivity criteria required for Class A pans, where 1 mm of precision corresponds to 1 liter of water per square meter - a critical measure for efficient water management in a Class A evaporation pan.

Nevertheless, the overall performance of the sensor suggests it may be suitable for other water monitoring contexts where millimetric resolution is not as stringent. Reservoir systems, storage tanks, low-complexity irrigation level control, or industrial applications could benefit from the sensor's automation capabilities and general responsiveness, provided it is properly calibrated and adapted to specific usage conditions.

## FINAL CONSIDERATIONS

The analysis of the data obtained from the four tests conducted with the S5-E200 sensor revealed that, although the device demonstrated the ability to detect variations in the height of the water column, it was not suitable for replacing the micrometric screw in the Class A evaporation pan. The arithmetic means indicated that the sensor responded consistently within height blocks, but with discrete and spaced changes, which compromises the detection of precise 1 mm variations — a fundamental requirement for reliable reference evapotranspiration (ETo) estimates.

Furthermore, the average standard deviation of 8.5 ohms in the Arduino-based automated system highlighted significant fluctuations, attributed to the indirect method of calculating electrical resistance, based on voltage readings and the use of an external resistor.

Although functional, this approach introduces noise and limitations that affect point-by-point measurement accuracy. Therefore, the sensor does not meet the sensitivity criteria required for high-precision agricultural applications.

However, its overall performance suggests feasibility for other water monitoring systems with less stringent resolution requirements, such as reservoir monitoring, storage tanks, or low-complexity irrigation systems, provided it is properly calibrated and adapted to specific usage conditions.

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