Research Phase 2 - A guide to Selecting Sensors

# Smart-Agro

IoT Agricultural Solutions

Digital Labs - Sri Lanka Telecom PLC

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# AGRI SENSORS – A COMPREHENSIVE ANALYSIS

## A guide to decide on the best sensor options to be used in the smart agricultural IoT system

### Introduction

The sensor is a part of the front end of an IoT system which collects data directly or indirectly from the surrounding environment on the Internet of Things network. But all sensors are different, and different IoT applications require different types of sensors.

Selecting the best suitable sensors for any IoT application is crucial for its desirable functionality, performance, and durability. The choice always depends on the types of information to be gathered and the purpose of the solution in general.

The quality of the sensor is of utmost importance in obtaining a favorable outcome. Since Data Analytics is another focus of smart solutions in addition to simple data display, the accuracy of the gathered data and its authenticity is essential for the success of the product. Durability of the sensor and the ability to withstand harsh environmental conditions (especially in agriculture) is another key factor to be considered in order to minimize any additional costs involved in maintenance.

This Report guides step by step through different types of sensors that can be incorporated in a smart agricultural system and gives a comprehensive analysis one the features, technical specifications and prices of each sensor to intuitively learn the options available in the market and select the best for the project.

# Types of Sensors

## Soil Moisture Sensors

Soil moisture sensors (also known as soil humidity sensors) are an important tool for detecting the moisture content of soil. Moisture sensors with additional functionality can also determine several factors related to soil health, including the soil temperature, salinity, or fertility in real-time.

### *Why measure soil moisture?*

Soil moisture affects the field climate, soil aeration and nutrient decomposition, and is one of the important conditions for soil microbial activity and crop growth and development.

### *Which soil moisture sensor type is the best?*

The most commonly used technology types of moisture sensors available in the market are:

- Time Domain Reflectometry (TDR) method
- Frequency Domain Reflectance Method/Frequency Domain (FDR/FD) Method

### *How does a dielectric moisture meter work?*

Dielectric soil moisture sensors determine the soil moisture by measuring the dielectric constant of the soil. The electrical characteristics of the soil changes with its dielectric property depending upon the soil's current texture. Dielectric constant (Ka) for dry soil is between 3 and 5; 1 for air; and is about 80 for water.

**dielectric constant:** The dielectric constant is ratio of the ability of an electrical insulating material (a dielectric) to store electrical energy in an electric field (permittivity) to that of free space.

*Industrial grade soil moisture sensor options:*

**1. Soil Sensor with three-in-one transmitter (H, T & EC) by Renke**



| Soil moisture sensor | Soil temperature and humidity sensor | Soil temperature and humidity conductivity 3 in 1 sensor |
|---|---|---|
| $32 | $39.9 | $45.8 |

- Measures three parameters of soil: soil moisture content, electrical conductivity (salinity), and temperature.
- Working principle: measures the dielectric constant of the soil
- Usability: plug-and-measure portable soil moisture meter, or can be connected to a general data collector to realize long-term dynamic monitoring
- Can be buried into the soil directly for long term dynamic detection
- Adopts the TDR frequency domain reflection principle
- multiple options for output mode such as rs485 (Modbus protocol), 0-5v, 0-10v, 4-20ma
- Specifications:
  - Probe length: 70mm
  - Probe diameter: 3mm
  - Probe material: 304 stainless steel
  - Sealing material: epoxy resin (black flame retardant)
  - Cable length: standard two meters
  - Protection level: IP68 (to ensure that the body is waterproof and anticorrosive)
  - Soil moisture measurement area: within a cylinder with a radius of 7cm centered on the central probe

- Properties
  - Corrosion resistant and non-electrolytic
  - Salt-alkali resistant
  - Suitable for all kinds of soil
  - Waterproof
- **Datasheets available on company website under soil moisture sensor.**
- *Link - https://www.renkeer.com/product/soil-moisture-sensor/*

2. **Seeedstudio - industrial-grade MODBUS-RTU RS485 Soil Moisture and Temperature Sensor**



| S-Soil MT-02A with hook-up wires | S-Soil MT-02B with waterproof aviation connector |
|---|---|
| $79.00 | $79.00 |

- Specifications are similar to above.
- *Link - https://www.seeedstudio.com/RS485-Soil-Moisture-Temperature-Sensor-S-Soil-MT-02-p-4634.html*

### 3. SenseCAP S2104 - LoRaWAN Soil Moisture and Temperature Sensor

| Product | |
| --- | --- |
| **Price** | **$129** |
| Communication protocol | LoRaWAN wireless transmission<br><br>• Long range data acquisition<br>• Ultra-low power consumption<br>  Maximum 10 years of battery life<br>• Ultra-wide-distance transmission range<br>  Can cover a transmission range of 2km in urban scenes and 10km in line-of-sight scenes |
| Soil Temperature Measurements | • Range from -40 to +80 °C<br>• Accuracy ±0.5 °C |
| Soil Moisture Measurements | • Range from 0 to 100% (air-water)<br>• Accuracy ±5% |

4. **ICT international**



| MP306 and MP406- Standing Wave Sensors | 10HS – Capacitance Sensor | TDR Sensor by Soilmoisture Equipment Corp. (SEC) |
|---|---|---|

- **Prices – N/A**
- Trase TDR soilmoisture probes by soilmoisture equipment corp. (sec)
- *Link - https://www.soilmoisture.com/tdr-waveguides/*
- ICT international link - *https://ictinternational.com/products/soils/moisture-sensors/*

5. **Available online:**

| Product name | 4 in 1 Soil Moisture Temperature Electrical Conductivity Sensor |
|---|---|
| Manufacturer | Raindao science and technology co. ltd |
| Measurement parameters<br><br>• Soil moisture<br>• Temperature<br>• Electrical conductivity<br>• Salinity |  |
| Price | $70 / 25,836.63LKR<br>(Shipping not included) |

| | |
|---|---|
| Output Signal | RS485 (standard Modbus-RTU protocol) |
| Output signal with wireless | LoRa / LoRaWAN |
| | GPRS/4G |
| | WiFi |
| | Nb-IoT |
| software | Free software for online monitoring and downloading data through the wireless module |
| Temperature measurement range | -30°C ~ 70°C |
| Temperature measurement accuracy | ±2°C |
| Temperature measurement resolution | 0.1°C |
| Moisture measurement range | 0 ~ 100% ($m^3/m^3$) |
| Moisture measurement accuracy | ±2% ($m^3/m^3$) |
| Moisture measurement resolution | 0.1% |
| Salinity measurement range | 0 ~ 10000ppm |
| Salinity measurement accuracy | ±3% in the range of 0-5000ppm |
| | ±5% in the range of 5000-10000ppm |
| Salinity measurement resolution | 10ppm |
| Supply voltage | 4.5~30V DC |
| Stabilization time | <1 sec |
| Response time | < 15 sec |
| Waterproof grade (safety) | IP68 |
| Sealing material | Epoxy resin |
| Probe material | Austenitic 316 stainless steel (Anti-rust, anti-electrolysis, salt, and alkali resistance, Suitable for all kinds of soil) |

*Low-cost options:* Available online:

1. **Resistive soil moisture sensor**

| Product | **Sheng Yang** Soil Moisture Detector Module Soil Humidity Sensor |
|---|---|
|  | • **Corrosion Resistance Probe**<br>• Operates at DC 3.3-12V<br>• **Price $3 to $10** |

2. **Capacitive Soil moisture sensor**

| Manufacturer | Raindao science and technology co. ltd |
|---|---|
| **Price** | **$11 / 4306.11 LKR**<br>**(Shipping not included)** |
| Product name | V2.1 Full scale analog Capacitive soil moisture/humidity sensor<br>Model RD-CSM-1 |
| Measurement parameters<br>• Soil moisture |  |
| Product name | V3.1 Soil Temperature and humidity sensor<br>RS-485/Modbus-RTU |

| Measurement parameters |  |
|---|---|
| • Soil moisture | |
| • Soil Temperature | |
| Output Signal | RS485 (standard Modbus-RTU protocol) |
| Output signal with wireless | LoRa / LoRaWAN |
| | GPRS |
| | WiFi |
| | Nb-IoT |

*Other Options:*

In large fields – soil tensiometers are ideal soil moisture monitoring

sensors. Available at Renke at **Price: $78~$102.9**



*Which moisture sensor to use in development stage?*

The simplest low-cost moisture sensors that can be used for prototyping and development purposes can be divided into two different categories:

1. **Capacitive soil moisture sensor:**

This type of sensors measures the changes in capacitance caused by the changes in the dielectric contrast between water and soil. Dry soils have a relative permittivity between 2-6 and water has a value of roughly 80. This sensor's metal electrodes do not have direct exposure to the outside environment. Therefore, there is no electrolysis damage occurred in the sensor and long lifetime can be guaranteed due to **less corrosion**. But these sensors only work with 5V operation voltage.

2. **Resistive soil moisture sensor:**

The sensor consists of two metal probes inserted into the soil, where the soil functions as a resistance to the current flow through the complete closed circuit. Water is a natural conductor of electricity, whilst dry soil is not. This resistance of the probe is inversely proportional to the soil moisture of the device. This sensor produces an output voltage according to the resistance by measuring which we can determine the moisture level. These sensors work with both 3.3V and 5V operation voltages. The soil moisture sensor module consists of a high precision comparator - LM393 which converts the incoming analog signal to a digital signal.

The main drawback with these types of sensors is electrolysis damage causing **corrosion** leading the sensor to become inaccurate several days after use.
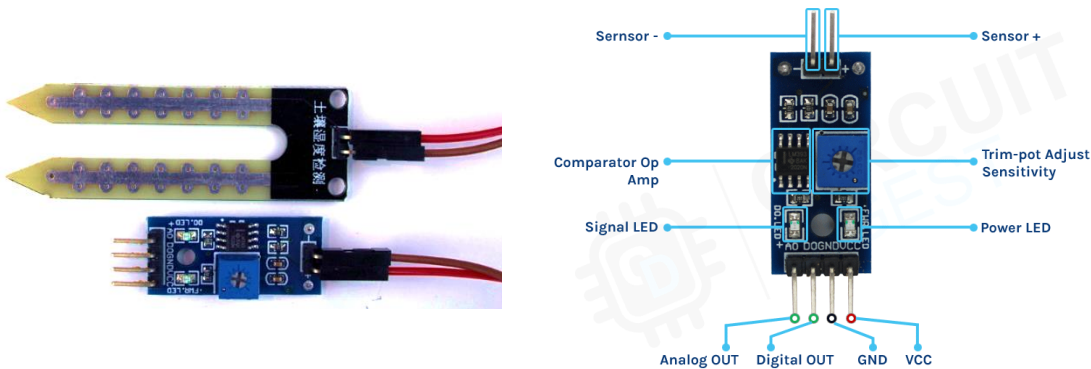


### *How to place the sensors?*

Due to the variability in soil structure and texture, the moisture content in the same plot is different from place to place. Therefore, sensors should be placed at several different depths and locations in the field. This depends on the type of sensors used and the area it covers.

### *How much area can a soil moisture sensor cover?*

It depends on the sensor. Most sensors can cover an area of 1 to 2 acres, and some sensors can cover more. Simple prototyping sensors cover up to 30-40cm.

**Sensor used in the project for initial development: YL69 resistive type soil moisture sensor**

# Temperature Sensors

In Agriculture, Soil temperature is crucial for crop growth. The temperature of the soil affects a series of physical, chemical, and biochemical processes in the soil which has direct impacts on the physiological process, external shape, and internal structure of the crops. Temperature Sensors are used to detect the temperature changes occurred.

In addition to soil temperatures, another vital parameter to be kept under control is the ambient temperature of the surrounding environment.

At present contact, non-contact and simulation methods are mainly used in measuring and forecasting soil temperature. Contact type has a direct contact with the measurand while the non-contact type detects the intensity of infrared rays emitted from the measurand to calculate the temperature.

Popular IoT temperature sensor manufacturers include:

- Texas Instruments
- Siemens Process Instrumentation
- Digital Instruments

Most Agricultural sensors today are multi-functional sensors (as mentioned in above examples). Therefore, a soil temperature sensor incorporated with humidity and/or EC sensors or more can always be used. Nevertheless, some examples of standalone temperature sensors that can be used to measure ambient conditions of the surrounding environment are as follows:

1. **Modbus RTU air humidity and temperature sensor by Renke**

| Product | |
|---|---|
| |  |
| **Price** | **$9 with 2-year warranty** |

| Temperature Measurement Range | - 40°C to 120°C |
|---|---|
| Temperature display resolution | 0.1°C |
| Humidity Measurement range | 0~100%RH |
| Humidity display resolution | 0.1%RH |
| Temperature and humidity refresh time | 1S |
| Power supply (default) | 10-30V DC |
| Power consumption | 0.3W |

2. **Industrial air temperature and humidity sensor wall mount by Renke**

| Product |  |
|---|---|
| **Price** | **$2**5.16 |
| Output signal | RS485 and analog output modes. |
| Installation method | wall-mounted |
| Power supply | DC 10-30V |
| Protection grade | IP65 |
| | Waterproof and good air permeability |
| | in-built industrial grade microprocessor |
| **Sensor Probes** |  |
| **Price** | **$7.3~$33.9** |

Documentation available on the manufacturer's website

3. **Air temperature, humidity, and pressure sensor by Raindao science and technology co. ltd**

| product |  |
|---|---|
| price | N/A |
| Temperature measurement range | -40~60°C |
| Temperature measurement resolution | 0.01°C |
| Temperature measurement accuracy | ±0.3°C |
| Humidity measure range | 0-100%RH |
| Humidity resolution | 0.05%RH |
| Humidity measure accuracy | ±5%RH |
| Air Pressure measure range | 30-110KPA |
| Air Pressure measure resolution | 0.1MBAR |
| Signal output | RS485 LoRa LoRaWAN NB-IOT GPRS |
| Power | DC7.5-24V |
| Protection Level | IP65 |

4. **SenseCAP S2101- LoRaWAN Air Temperature and Humidity Sensor by seedstudio**

| **Product** |  |
|---|---|

| Price | $59 |
|---|---|
| Communication protocol | LoRaWAN wireless transmission<br><br>• Long range data acquisition<br>• Ultra-low power consumption<br>  Maximum 10 years of battery life<br>• Ultra-wide-distance transmission range<br>  Can cover a transmission range of 2km in urban scenes and 10km in line-of-sight scenes |
| Temperature Measurements | • Range from -40 to +85 °C<br>• Accuracy ±0.5 °C |
| Humidity Measurements | • Range from 0 to 100% (air-water)<br>• Accuracy ±5% |
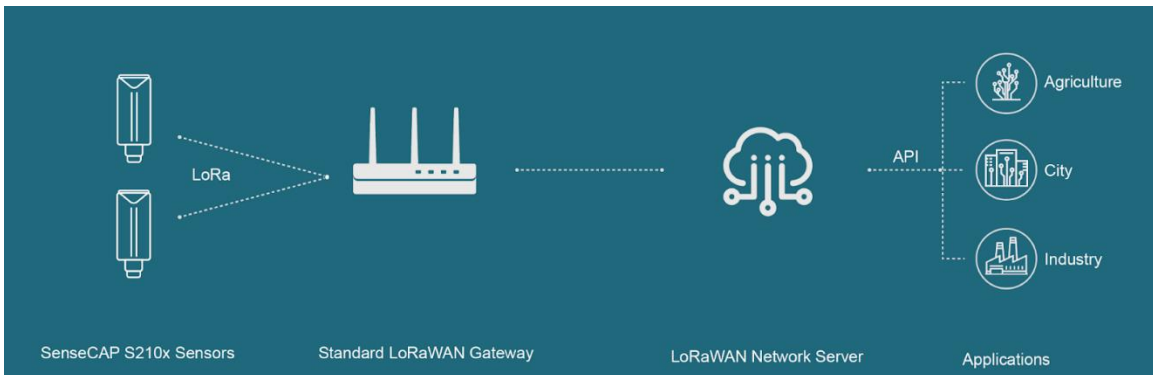
# Humidity Sensors

The humidity sensor can measure the water vapor content in the air. Humidity affects plant growth in several ways. When relative humidity levels are too high or there is a lack of air circulation, a plant cannot make water evaporate (part of the transpiration process) or draw nutrients from the soil. When this occurs for a prolonged period, a plant eventually rots. Maintaining appropriate air quality is mostly important for indoor agricultural methods such as greenhouses.

Popular IoT humidity sensor manufacturers include:

- iST
- Amphenol
- Laird

Almost all the industrial grade sensor modules incorporate both temperature and humidity sensors in one device/sensor. **(Examples given under Temperature sensors)**

# Soil PH sensors

PH sensors reflect availability of ionic elements in the soil. This helps to obtain a quantitative understanding of the soil conditions. Too low or too high pH will affect nutrient absorption. It then helps gather data to analytically obtain critical feedback regarding soil nutrient deficiencies or the presence of unwanted chemicals in soil. Soil PH not only balances the nutrient level of soil but also has a significant impact on the life activities of microorganisms in the soil.

If the soil is too acid or alkaline, it will affect the root growth of plants to a certain extent, thereby affecting the normal growth and development of plants. Soil acid-base imbalance can also reduce the availability of nutrients in the soil and affect soil fertility. Therefore, soil PH sensors helps to understand the soil quality and apply fertilizer reasonably

1.  **Soil PH sensor by Renke**

| | |
|---|---|
| **Product** |  |
| **Price** | **$40** |
| Measuring Range | 3—9 PH |
| Resolution | 0.1 |
| Output signal: | RS485/4~20mA/0~5V/0~10V |
| Measuring area | Diameter of 5cm, cylinder with the same height as the probe  |
| Probe material | Anti-corrosion special electrode |
| Sealing material | Black flame-retardant epoxy resin |
| Protection level | IP68 |

| Response time | ≤10S |
|---|---|
| Power supply | 5-30V DC |
| Maximum power consumption | 0.5W |

2. **Soil PH and Temperature sensor by Raindao science and technology co. ltd**

| **Product** |  |
|---|---|
| **Price** | **N/A** |
| PH Measuring Range | 4-10 PH |
| PH Resolution | 0.1 PH |
| PH measurement accuracy | ±0.5PH |
| Temperature Measuring Range | -20–60℃ |
| Temperature Resolution | 0.1℃ |
| Output | RS485 ,LoRa,LoRaWAN,GPRS,NB-IOT |
| Protection level | IP65 |
| Power supply | 12–24V DC |
| Average power consumption | 48 mW |

### 3. Sensors Available online

| Product |  |
|---|---|
| **Product Name** | Soil PH and temperature 2 in 1 sensor |
| **Price** | **LKR 24,415.50** |
| PH Measuring Range | 3-10 PH |
| PH Resolution | 0.1 PH |
| PH measurement accuracy | ±0.2PH |
| Temperature Measuring Range | -20–60℃ |
| Temperature Resolution | 0.1℃ |
| Output | RS485/4~20mA/0~5V/0~10V |
| Output with wireless | LoRa,LoRaWAN,GPRS,WiFi,NB-IOT |
| Protection level | IP68 |
| Probe type | AgCl Anti-corrosion reference probe |
| Power supply | 12–24V DC |

# Soil NPK sensors

Plants need significant amounts of Nitrogen, Phosphorus, and Potassium to grow and thrive.

## *Why add NPK to plants in forms of fertilizer?*

- **Nitrogen** is primarily responsible for vegetative growth. Nitrogen assimilation into amino acids is the building block for protein in the plant.
- **Phosphorus** is a major component in plant DNA and RNA. Phosphorus is also critical in root development, crop maturity and seed production.
- The role of **potassium** in the plant is indirect. However, Potassium is required for the activation of over 80 enzymes throughout the plant. Potassium increases water use efficiency and transforms sugars to starch in the grain-filling process

In the soil, nitrogen, phosphorus, and potassium basically exist in the form of organic compounds, but they are returned to the soil in the form of remnants and roots, but not many, and cannot be used directly by plants. In agricultural production, soil NPK sensors are suitable for detecting the content of NPK in the soil as an indicator to measure soil fertility and guide production.

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## *Industry grade Sensor Options:*

1. **Soil NPK sensor by Renke**

| Product |  |
|---|---|
| Price | $52.3 |
| Features | • stainless steel probe |

| | |
|---|---|
| | • durable and resistant to long-term electrolysis, salt, and alkali corrosion. <br> • The shell is vacuum potted and completely waterproof |
| NPK parameters | • Range: 0-1999 mg/kg(mg/L) <br> • Resolution: 1 mg/kg(mg/L) <br> • Precision: ±2%FS |
| Output signal | RS485/4-20ma/0-5v/0-10v |
| Response time | ≤1S |
| Power supply | 5-30VDC |
| Maximum power consumption | ≤0.15W |
| Protection grade | IP68 |

2.  **Taidacent RS485 Soil NPK PH Sensor**

| | |
|---|---|
| Product |  |
| Price | $175.58 with 2 year warranty |
| NPK parameters | • Range: 1-1999 mg/kg(mg/L) <br> • Resolution: 1 mg/kg(mg/L) <br> • Precision: ±2%FS |
| Output signal | RS485/4-20ma/0-5v/0-10v |
| Response time | ≤1S |
| Power supply | 12-24VDC |
| Maximum power consumption | ≤0.15W |
| Protection grade | IP68 |

# Light/Optical Sensors

All plants require light for photosynthesis. But too much light can cause leaf burning in a plant and with insufficient light the plant sheds all the leaves and eventually dies. Therefore, maintaining adequate amount of light is an important factor in agriculture, especially in domestic indoor cultivation and greenhouses.

The light sensor can sensitively sense the light energy from ultraviolet light to infrared light and convert the light energy into electrical signals.

The light sensor is a kind of sensing device, which is mainly composed of photosensitive elements. The light sensor / illumination sensor is used for the outdoor measurement of light intensity. It is a high-precision light-sensitive transmitter with an output value measurement unit of Lux.

There four main types of light sensors:

- Ambient light sensor
- Infrared light sensor
- Sunlight sensor
- UV light sensor

*Industrial grade light sensors*

1. **Illumination sensor by Renke**
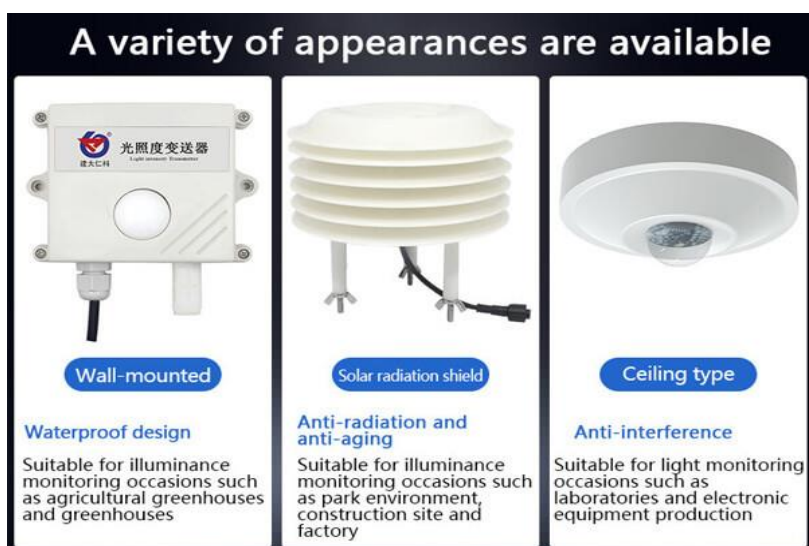
| Illumination sensor types by Renke | • **Wall-mounted** <br> • **Solar Radiation shield** <br> • **Ceiling type** |
|---|---|
| **Price** | **$19.9~22** |
| Measure range | 0-60000 Lux, 0-200000 Lux (optional) |
| Accuracy | ±7% |
| Power supply | 10-30VDC |
| Response time | 0.1s |
| Output signal | RS485/0-5v/0-10v/4-20ma |
| protection level | IP65 |

2. **SenseCAP S2102 - LoRaWAN Light Intensity Sensor by seeedstudio**

| **Product** |  |
|---|---|
| **Price** | **$59** |
| Communication protocol | LoRaWAN wireless transmission <br><br> • Long range data acquisition <br> • Minimal power consumption <br> • Maximum 10-year batter life <br> • built-in replaceable battery for minimal maintenance |
| Luminance Measurements | • 0 - 160000 lux <br> • Accuracy ±0.5% <br> • Resolution 1 lux |

# Rain and Snow Sensor

Rain and snow sensor qualitatively measures whether it rains or snows outdoors. This can be used as a precaution method to protect crops from heavy rainfall. In outdoor plots/greenhouses, if the precipitation is high, a shield/shelter could be integrated to automatically cover the crops

| Product | Rain and snow sensor by Renke |
|---|---|
| |  |
| **Price** | **$25.2** |
| Protection Level | IP68 High-strength, corrosion resistant ABS waterproof material |
| Output modes | Rs485 and switch value |

# CO2 Sensors

Carbon dioxide is one of the raw materials for photosynthesis of green plants. It is very important to use carbon dioxide sensors to monitor the CO2 concentration in greenhouses because if the greenhouse has been kept closed for a long time, causing the air in the room to be relatively blocked and unable to replenish carbon dioxide in time, after sunrise, due to the accelerated photosynthesis of vegetables, the indoor carbon dioxide concentration drops sharply, and sometimes drops below the carbon dioxide compensation point. Vegetable crops can hardly carry out normal photosynthesis, which affects the growth and development of vegetables, causes diseases, and reduces yield.

1. **CO300 $CO_2$ Sensor**

   **Technical Specifications:**

   Input voltage: 13-24V DC

   Output voltage: 0-5V DC

   Consumption: 100mARH

   range: 20-95%

   Operating temperature: -20° to 55°C

   Accuracy: 75 PPM or 10% of reading (whichever is greater)

   **Price: N/A**

2. **S8 Miniature 1000 ppm CO2 Sensor**

| Product | |
|---|---|
| |  SE-0119 |

| Vendor | co2meter.com |
|---|---|
| Price | **$99 / 34,578.24 LKR** |
| Features | Low Power, Small Footprint Design<br><br>Automatic Background Calibration |
| Measurement Method | diffusion |
| Measurement Range | (0-10,000 ppm) |
| Response time | 90% at 2 minutes |
| Accuracy | ± 70ppm |
| Communication Options | UART Modbus |
| Available Output | analog |
| Sensor Life Expectancy | > 15 years |
| Power Input | 4.5-5.25 VDC |
| Power Consumption | 30mA average |

3. **MIX8121 CO2 Detection Sensor**

| Product |  |
|---|---|
| **Price** | **$8** |
| Features | • High sensitivity to $CO_2$<br>• Low cost, long life<br>• Good stability<br>• Simple application circuit<br>• Low power consumption |
| Target Gas | $CO_2$ |
| Measurement Range | 350 ~ 10000ppm ($CO_2$) |
| Power consumption (PH) | 450mW±50mW |

# Additional Sensor Options

## Leaf Wetness sensors

Lead Wetness sensors are designed to detect wetness of leaves. Measuring leaf wetness is important in some agricultural environments for fungus and disease control. They can also be used for fog and dew conditions detection as well as rainfall prediction.

### 1. Leaf wetness sensor by Renke

The working principle of the sensor is to measure wetness through the change of the leaf surface dielectric constant. With denser leaf vein patterns (15 lines/cm) on the surface, smaller droplets can be detected, and the measurement is more sensitive. The sensor surface coating is non-hygroscopic, eliminating false wetness detection. The sensor offers high precision faster responses. The sensor is Epoxy resin encapsulated, waterproof and moisture-proof. It has IP67 protection level, and gurantees long using life.

**Price $36**

## Image sensors

Image Sensors are advanced sensors that can be used for detection of weeds to identification of soil fertility. The main limitation to the use of optical sensors in agriculture in most parts of the world has been the cost of purchasing the devices. Optical sensors can be installed in drones to monitor large fields but for urban domestic agriculture small scale installations are sufficient.

Optical sensors can determine clay, organic matter, and soil moisture content.

https://www.researchgate.net/publication/332737810_Optical_Sensors_for_Precision_Agriculture_An_Outlook

# Final Analysis of the sensors suitable for the project

The key parameters to be measured in an agricultural IoT application are:

- Soil Moisture/Humidity
- Soil Temperature
- Soil PH value
- Soil Salinity and EC
- Soil NPK value

Apart from soil parameters ambient conditions of the environment must be guaranteed for optimal yield. Especially in a greenhouse, it is ideal to measure the following parameters:

- Ambient Air Temperature
- Ambient Air Humidity
- Ambient Light
- $CO_2$ concentration

Today's market offers many cost-effective solutions specially designed for agricultural monitoring applications. Out of the many, the intelligent option is to buy an all-in-one sensor to measure soil properties. Thereby, reducing the initial buying cost, maintenance cost as well as saving space and aiding in methodical installations.

*All in One Soil Sensor Options Available in the Market*

1. **7 in 1 soil nutrient sensor by Renke**

| Product |  |
|---|---|
| **Price** | **$104.5** |

| Parameters Measured | • Soil moisture |
| --- | --- |
| | • Soil Temperature |
| | • Soil PH |
| | • Electrical conductivity |
| | • Nitrogen |
| | • Phosphorus |
| | • Potassium |
| Power supply | DC 4.5-30V |
| Maximum power consumption | 0.5W (24V DC power supply) |
| Working temperature | -20℃~+60℃ |
| Core chip temperature resistance | 85℃ |
| Protection grade | IP68 |
| Probe material | Anti-corrosion special electrode |
| Sealing material | Black flame-retardant epoxy resin |
| The default cable length | 2 meters, the cable length can be customized as required |
| Dimensions | 45*15*123mm |
| Output signal | RS485 |

*Available online:*

2. **Taidacent**
   - Measurements - Soil nitrogen, Phosphorus, Potassium, PH Conductivity, Temperature and Humidity
   - Price: $450.58
   - Features and Specification: Similar to above

3. **5 in 1 soil sensor**
   - Measurements - Soil Temperature Humidity Moisture Conductivity EC PH Sensor
   - Price: LKR 9694.39
   - Features and Specification: Similar to above

4. **8 In 1 Lora LoRaWAN Soil Moisture Temperature EC Salinity PH NPK Sensor With LoRaWAN Collector**

| Product | |
|---|---|
| |  |
| Vendor | **Raindao science and technology co. ltd** |
| Price | **LKR 358,842.10 (shipping not included)** <br> *This price may vary with integrated sensor types* |
| Integrated sensors <br> (Sensors to be integrated are customizable) | • **Soil Moisture** <br> • **Soil Temperature** <br> • **EC** <br> • **Soil Salinity** <br> • **Soil PH** <br> • **Soil NPK** |
| Power supply voltage | DC 12 ~ 24V |
| Power consumption | 5W |
| Communication interface | RS485, RS232 |
| Serial Port | The serial port is equipped with RS-485 as standard, and the baud rate range is 1200bps ~ 115200bps |

| | |
|---|---|
| Communication protocol | MODBUS-RTU |
| Communication rate | 300Kbps, programmable. |
| Communication method | Active upload |
| Lora working frequency band | wireless 410 ~ 525MHZ, 863-870MHZ,902-928MHZ, 915-928MHZ, ISM global free frequency band, Lora spread spectrum modulation, support FSK, GFSK, MSK, GMSK, OOK modulation methods |
| Networking | Star wireless network |

# Precautions to follow to make sensors durable

1.  Sensors with probes should be inserted 90 degrees vertically into the soil. The sensor should be refrained from shaking while insertion. Otherwise, the probes might get bent and damaged.

2.  If the sensors are to be inserted into the soil, the sensor should be inserted parallel. This method is used in multi-layer soil moisture detection.

3.  The stainless-steel probes should be fully inserted into the soil and all lumps or foreign objects such as hard rocks should be removed before insertion.

4.  The housing of most sensors is potted with black epoxy resin. Thereby, can get damaged due to high temperatures and direct sunlight.

5.  The signal wire of the sensor should not be exposed in a place with high temperature and high humidity.

6.  When storing the soil sensor, the stainless-steel needles should be wiped and cleaned with dry paper towels, covered with foam, and stored in a dry environment at 0-60°C.