

## User Information

This note contains important user information for Sensoterra Single Depth probes. The contents in this document may change over time, incorporating product improvements and learnings from the field.

### Our philosophy

The design of the Sensoterra probe is a game changer on four different features:

1. *Low cost level.* About 3-5 times lower purchase cost, which includes wireless communication. No subscription fees apply.
2. *Fast installation.* Probes are installed in 30-90 seconds and can be moved around in the field as you prefer.
3. *Long lifetime.* The rugged design allows to use a rubber hammer at installation. The battery lasts 3-10 years, depending on operation.
4. *Open API.* You get the most out of your soil moisture data when using advanced crop models that integrate several data like weather and soil information.

These unique features are essential for a device to function in the world of Internet-of-Things. Millions of data sources are combined to improve operations. Growers obtain higher yields, better product quality and more efficient use of resources like water, fertilizer and pesticides.

Due to the unique Sensoterra features, growers can start to use many soil moisture probes. Typically, we recommend 3-6 probes per pivot or irrigation control area. Depending the crop type, we recommend probes at different depths.

### Installation guidelines

#### The probe

Best performance is obtained when the probes are pushed in the soil, without pre-digging a hole. In that case, soil contact is optimal and soil disturbance is minimal. If it is too hard to push the probe in, there are 3 options:

- Use a small rubber hammer to gently hammer the probe in the soil. Use many small strokes, rather than a few heavy ones.

- Use a steel strip of 4 mm thick, 25 mm wide and about 2-3' long (60-100 cm). These are sold by us or can be obtained at a hardware shop. The strip is hammered in and pulled out, and the probe is pushed into the hole. It is important that the probe is pushed in at least 6" (15 cm) further than the hole, to ensure good soil contact.
- Dig a hole with a pole digger or shovel. Again, it is important that the probe is pushed in at least 6" (15 cm) further than the hole, to ensure good soil contact.

## The gateway

The gateway starts up itself. When plugged in, it becomes operational after about 10 minutes. Please make sure that the right antennas are placed for the cellular connection and for the RF/LoRa connection.

A good placement of the gateway considerably improves the communication range. Avoid obstructions like steel structures or water tanks. A higher placed antenna (between 10-30 feet, 3-10 meters) significantly improves the range. Most gateways have an SMA connector that can be fitted with an external antenna and an extension cable.

## Technical functioning

### Soil moisture measurement

Soil moisture is measured based on a proprietary and patent pending algorithm that combines impedance and resistance properties of the soil.

The absolute soil moisture reading depends on the soil type. Sand, clay or peat have different characteristics. You can choose the right soil type in the app. If you are not sure about the soil type, we recommend you use an average soil. The reading of the probe will change if you change the soil type. Soil moisture ranges from 0% to 40% for sand, 53% for clay and 83% for peat. Maximum soil moisture is set by the void volume in the soil that can theoretically be occupied by water.

### Accuracy

If the correct soil type is selected, the inaccuracy of the measurements is 0-20% relative. This means a deviation of maximum  $\pm 2\%$  at 10% soil moisture and  $\pm 6\%$  at 30% soil moisture. In our experience, that is more than sufficient for most applications. When using a calibration curve that is developed specifically for the soil, the accuracy is significantly higher.

Repeatability accuracy is 97%. That means, when measuring a sample of a certain soil moisture, the probe comes back with the same reading, even if a different probe is used or a different sample is used (of the same soil type and soil moisture content). Therefore, soil moisture trends are highly accurate.

Sensoterra soil moisture readings are affected by salinity. An increase in salinity of more than 0.5 mS/cm will give a 20% relative error. This is only observed in more extreme conditions, like when saline water is used for irrigation (Middle East). Normal fertilizing practices stay typically below 0.5 mS/cm.

## Product lifetime

The energy consumption is extremely low, allowing for years of operation. Batteries don't need changing. The probe is water tight for rain and irrigation (IP65) but it should not be submerged in water.

## Communication

The probe measurements are sent by radio (LoRaWAN) to a gateway. In most cases, you will have to purchase and install a gateway. In some cases (mostly urban), a provider like Comcast, Senet or KPN has installed gateways. In that case, you don't need to install gateways. We expect that going forward, more and more area will be covered by the providers, reducing the need for customers to install gateways. Data is sent by LoRa from the probe to the gateway, by 4G from the gateway to a server owned by the provider, and through the cloud to the Sensoterra server. Sensoterra has covered the cost for the provider gateway for a period of 3 years. After that, you will have to decide whether to continue the service. If so, a new fee will apply.

## Terms and conditions

### Warranty

We guarantee functioning of the probe for 1 year. In case you have a problem with a probe and you have confirmed that it is not a range issue, contact us and we will have it checked and replaced if required. This includes battery lifetime.

We don't guarantee the integrity of the casing or any damage due to hammering in. Experience with gently use of rubber hammers is positive (or a small steel hammer with a wooden block between the probe and the hammer). Hammering too hard or hammering with hard plastic or steel hammers will make the casing crack.

## Liabilities

We can't guarantee the quality of communication. It depends on our partners who provide communication services, like Comcast, Senet and KPN. It also depends on how far the probes are placed from a gateway and how thick the vegetation is between the probe and the gateway. In case you experience poor communication, try to place the probe higher above the ground, e.g., 6" (15 cm) between the blue casing and the soil. In case you operate in corn canopies or other orchards, we recommend to consider an extended antenna on the probe, about 3-6' (1-2 meters) tall. Please contact us in that case.

Sensoterra takes no responsibility on the performance of crops. All decisions based on Sensoterra information are the sole responsibility of the customer. Sensoterra accepts no liabilities and customers waiver any right to hold Sensoterra accountable when installing a probe through the app.

## Data management

Your data is stored in a database on our server. The server is protected by firewalls on both ends and all best practice security measures are applied, as specified by ISO 27001. This includes using the latest security patches, regular security audits, backups, encryption, etc.

Your data are provided to you for free for 10 years after purchase. You can look back and compare the readings to historic data. You can download the data at any time in several formats, like Excel. We also provide a free, open API and a Server Push Notification to allow easy integration of your data into other databases and models.

We will use data on an aggregated and anonymized basis to improve farming practices. It will not be possible to trace back the data to your specific operation. In case you prefer to keep your data only to yourself, we will provide you, for a one off cost of \$50 per probe, with a button to delete your historic data at any time.

## Terms and conditions

You can find the Terms and Conditions on the App (mandatory "accept" when you log in for the first time) and on the Sensoterra website:

<http://www.sensoterra.com/wp-content/uploads/2016/02/160211-General-conditions-of-sale-and-delivery-Sensoterra.pdf>