PLANT DIAGNOSTICS DEVICE
Smart Agrometer

User Guide

SMART AGROMETER

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Declaration of Conformity

CE	The device complies with the EMC directives: LST EN 61010-1:2011 LST EN 61010-1:2011/A1:2019 ETSI EN 301 489-1 V2.2.3 (2019-11) EN 301 511 EN 303 413 v1.2.
IP65	Safety class (protection from dust and light water pressure). Protect the device from heavy rain or submersion in liquid.
	Old Smart Agrometer devices must be returned to the company address. The recyclable bin indicates: No household waste

UAB "Žemdirbių Konsultacijos"

Reg. address: Kalniečių g. 83-15, Kaunas, LT-50176, Lietuva

Reg. no: 301695636

Email: info@agronom.lt

Tel. no.: +370 (633) 97353

www.agronom.lt

Purpose

The device is intended for plant nutritional assessment and fertilization recommendations.

Operating principle

On the principle of spectrophotometric measurement, the color spectrum of plant leaves is measured, based on which a nutrient deficiency of the plant is assessed and a recommendation is provided.

Spectral measurements are performed on **all fully developed** leaves of the plant, measured sequentially from the youngest (top) to the oldest (bottom) leaves of the plant.

The measurement results are sent to a server for processing with a proprietary machine learning algorithm. The user receives information about the condition of the plants and a recommendation for fertilization.

The device is in its testing stage and its accuracy is limited, so the fertilization advice is only a recommendation - we recommend that the user make decisions based on all available information about the field and plants, not just based on the device's fertilization recommendations.

Technical characteristics

Operational conditions and safety:
Ambient temperature range: 5-50° C
Humidity range: ⩽85%
Altitude: ⩽2000 m
Operating place: outdoor and indoor
Pollution Degree: 2 (as defined in IEC 61010-1)
Safety class: IP65
Protect the device from heavy rain, direct sunlight or submersion in liquids

The safety of the device can be impeded if used not according to instructions.

Plant cultures: The device is can analyze the following crops: summer wheat, winter wheat, barley, corn.
Dimensions: 220 x 110 x 40 mm
Calibration: Calibration is performed with white and black every time the device is restarted.
White calibration is performed by using the white calibration sheet
Black calibration is performed without calibration sheets
Battery: internal device battery is non replaceable.
USB port: used only for device charging and service. During operation, the device must be disconnected from any chargers and external devices.
Charging the device: charging voltage 5V, current 1A, charging duration 2 hours. Duration of operation of the charged device, at least 24 hours. The device is charged via a USB- B type connector.
Data transmission: via GSM.
GPS coordinate setting function: sends measurement coordinates to web portal

Maintenance and cleaning

Clean the device with a damp, soft cloth. Do not use any chemical cleaners or place under running water. Be very careful with the optical lenses under the leaf clamps. Clean the lens only when necessary with soft, damp tissues (i.e. glasses lens cleaning tissues). Clean the lenses softly, without any force.

Clean the calibration sheets with a stream of warm water using soap.
We recommend to clean the calibration sheets at least once per month.

Device management

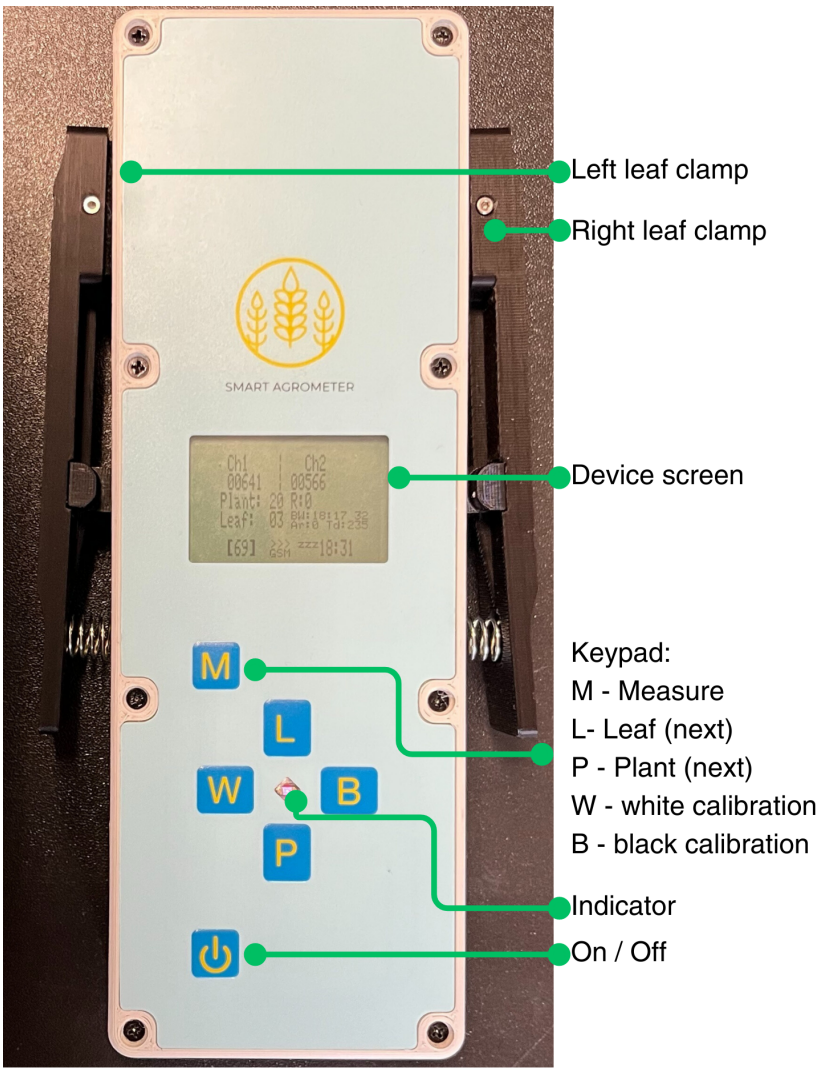


***Figure 1**. Layout of Smart Agrometer keyboard buttons and indicator.*

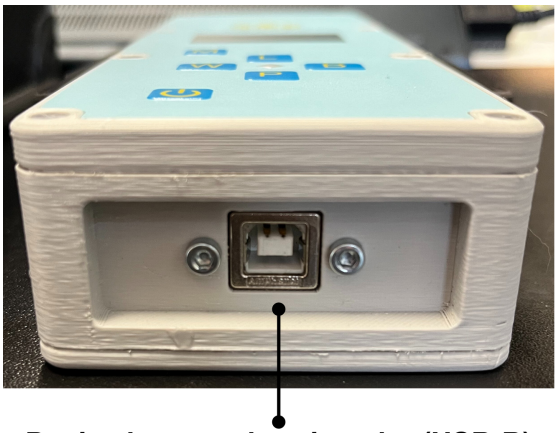


***Figure 2.** Smart Agrometer device charging socket (USB type B connection). Device has to be disconnected during measurements.*

The device is controlled using the keyboard. The purpose of the keyboard buttons:

Button	Measurement mode	Configuration menu
M	Measurement	Enter configuration menu (press and hold for more than 2 seconds)
L	Changing (increasing) leaf	Change selection (navigation)
P	Changing (increasing) plant	Change selection (navigation) Saving the selection (press and hold for more than 2 sec.)
B	Black calibration (BLACK)	-
W	White calibration (WHITE)	-
⏻	On/off	-

Workflow

Activation

- The device is turned on with the ⏻ button.
- Wait for the GPS and GSM icons to fully load (to turn green).
  - The letters GSM and GPS have to appear at the bottom of the screen

Calibration

- The device needs to be calibrated before use.
  - Black calibration
    - After making sure that nothing is under the measuring clamps, press the "B" (Black) button.
    - The device returns “Black Balance Done”

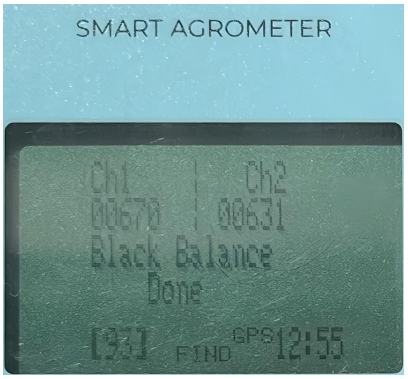


Figure 3. *Smart Agrometer - Calibration with black*

  - White calibration
    - Take the white calibration sheets and place them on the measuring slits on each side of the device, under the leaf clamps. Press the "W" (White) button.
    - The device returns “White Balance Done”

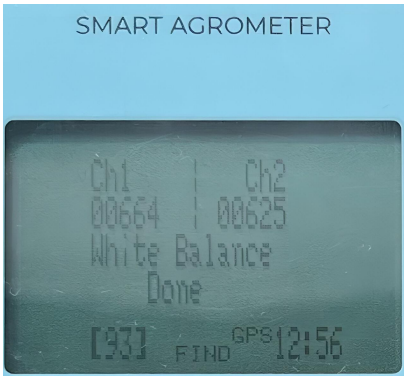


Figure 4. *Smart Agrometer - Calibration with white*

Preparation for the measurement session

- To begin a measurement session:
  - Press the "M" button for more than 2 seconds (activates configuration mode).
  - Select a new session with the "L" button ("New Session"):"Yes/No". The selection is saved with the "P" button, which must be pressed and held for 2 seconds.
  - Select the field ID (Field ID) is selected with the "L" button: (1...999). The selection is saved with the "P" button, which must be pressed and held for 2 seconds.
  - Select the plant species with the "L" button: summer wheat ("S. Wheat"), winter wheat ("W. Wheat"), corn ("Corn"), barley ("Barley"), the selection is saved with the button "P", which must be pressed and held for 2 seconds.
  - Select the plant vegetation stage (BBCH Scale) - “Growth st”. The selection is saved with the "P" button, which must be pressed and held for 2 seconds.
  - The "L" button selects the state of the plants: Healthy, Dried, Twisted, Mildew, Drechslera, Rust, Septoria). The selection is saved with the "P" button, which must be pressed and held for 2 seconds.
- Device configuration is performed each time measurements are started, when starting a new measurement session.

Figure 5. *Device configuration menu.*

Measurement

- Measurements are done by inserting a leaf under one of the measurement clamps of the device. Make sure to place the measurement slits on to the middle of the leaf. (Fig. 6).

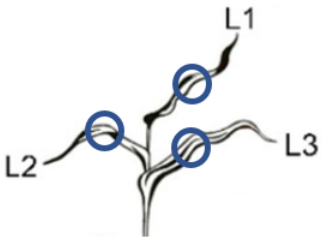


Figure 6. *Location of leaf measurements.*

- Selecting the first leaf. If it's a flag leaf - it must be fully developed, only then it can be measured. Other leaves are selected as shown in Figure 6. The first (youngest) leaf (L1) should be larger than half of the youngest leaf, for example: Figure 7, a - L00 the youngest leaf is less than half of L0, and L0 is already larger than half of the L1 leaf, so L1 is measured first. Figure 7, b - L0 is greater than half of L1.

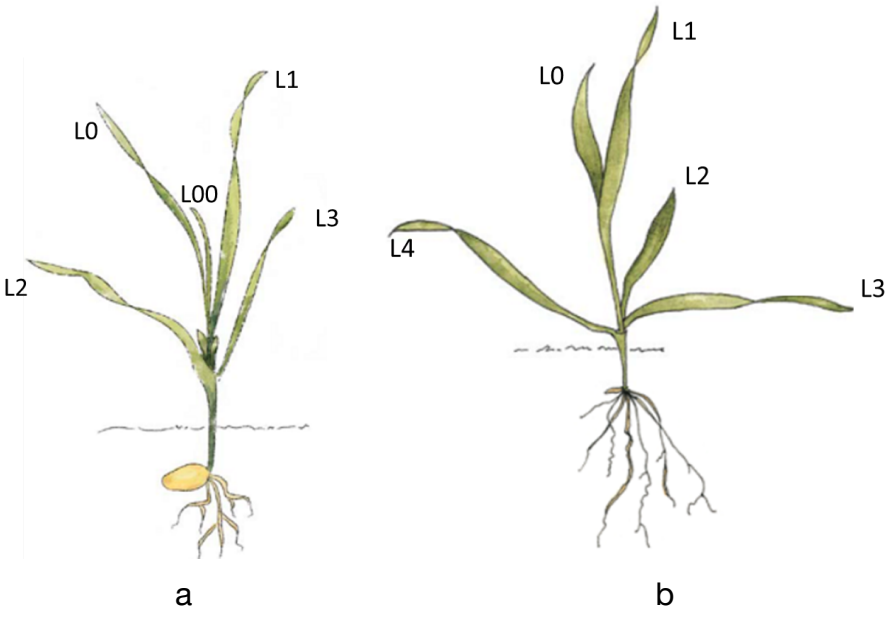
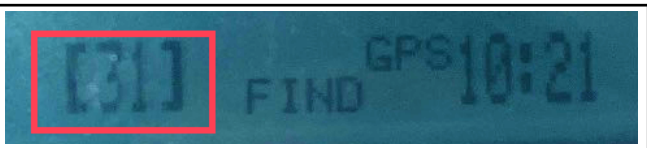


Figure 7. *Identifying the youngest leaf*

- When inserting the leaf under the clamp, position it so that the middle part of the upper side of the leaf completely covers the measuring slit (located under the positioning mark on the clamp).
- After covering the leaf with the clamp, click the "M" button.
- Once a measurement is done, the leaf measurement number changes in the display
- We recommended measuring the same leaf 3 times, slightly changing the position of the leaf under the clamp.
- When measuring plant leaves, the top (youngest) fully developed leaf ("1") is measured first.
- After measuring the first leaf, press the "L" (Leaf) button, changing (increasing) the number in the display ("2").
- When the second leaf (lower) is measured, press the "L" (Leaf) button again
- All fully developed leaves are measured from the top (first) to the bottom. The number of leaves on a plant depends on the type of plant and the vegetation stage (Growth st.)
- After measuring all the leaves of the plant, press the "P" (Plant) button and change (increase) the number of the measured plant and move on to the next plant.
- A total of 20 selected plants should be examined in one field location (one session).
- After measuring all the selected plants, press the "M" button for more than 2 seconds, entering the configuration menu and changing (increasing) the session number (see point 2.1).
- The screen of the device in the measurement mode is presented in Fig. 9.
- The screen displays:
    - the number of the measured plant (P)
    - the number of the measured sheet (L)
    - the number of the measurement in (the number of times “M” was clicked on a single leaf) (R)
- Battery and connectivity indicators:

Battery level (%)		
Battery is charging, battery level (%)		

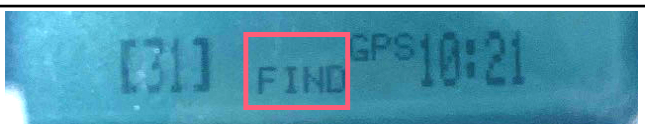
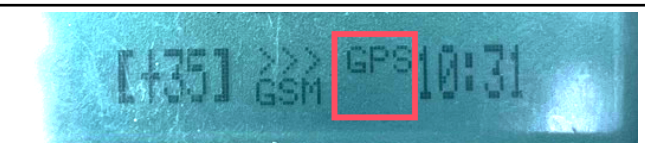
Device is searching for GSM signal		
Device connected to GSM; GSM signal strength		
Device is searching for GPS signal		
Device connected to GPS		
Data transfer to server		

Figure 8. *Main battery, GPS & GSM indicators on the device screen*

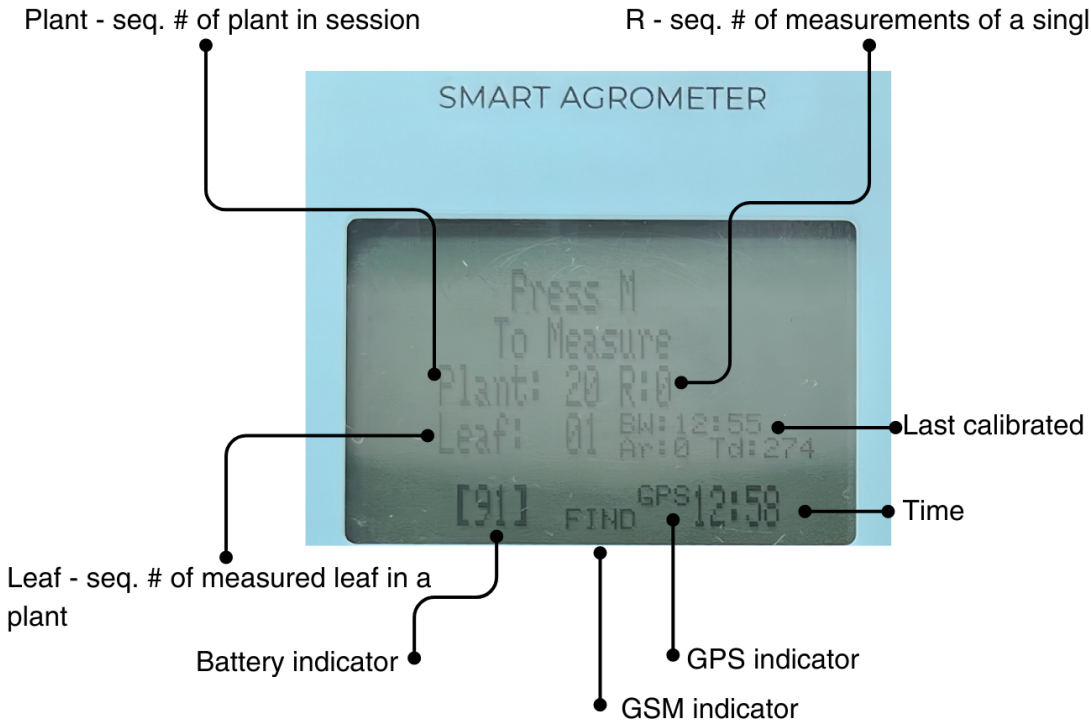


Figure 9. *Device screen in measurement mode*

Data transmission and diagnostic information.

- The measurement data is sent to the data server automatically when the device has an active GSM connection (GSM visible in the bottom of the screen)
- The data from each measurement session is processed on the server, using a special machine learning algorithm to determine which substances (micro or macro elements) are missing from the studied plants from each session.
- The user can find information about identified plant nutritional deficiencies and fertilization recommendations by logging into his account at app.agronom.lt

Recommendations for measuring plants in the field

Plant measurements with the Smart Agrometer are taken from 4-5 places. 20 plants per location are measured. Measurement sites are selected randomly by walking across the field in a zigzag pattern (Fig. 10).

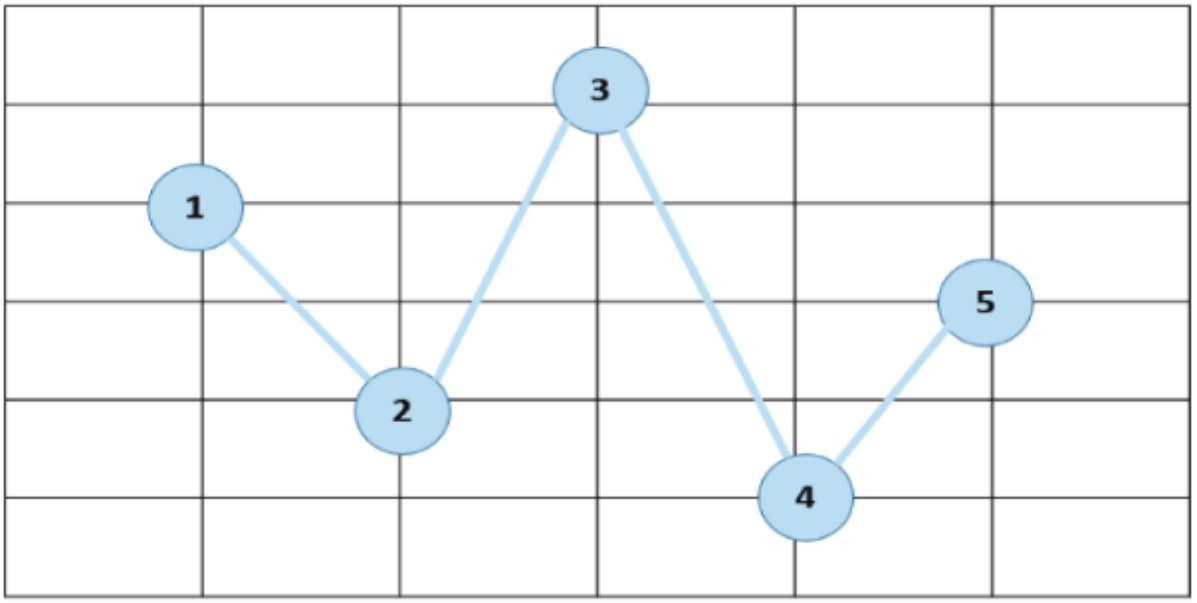


Figure 10. *Locations for plant measurements (sessions) and sampling*