EGU23-16827 | Sesion GI6.5
Fri 28 Apr, 15:20–15:30 Room -2.91

# Testing mobile ground-based gamma-ray spectroscopy for measuring $^{40}K$ in an agricultural field (Spain)

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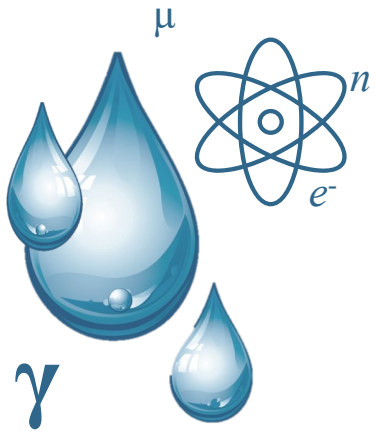
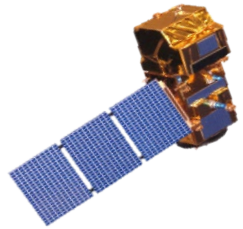
# Soil Water Content with Nuclear Techniques

## Proximal Gamma-ray Spectroscopy

- Effective technique for monitoring the spatial and temporal distribution of terrestrial radioelements like $^{40}K$
- In recent years, PGRS has become a promising sensor to infer topsoil water content at an intermediate field scale (supported by adequate calibration and corrections)



Remote Sensing products

Cosmic-ray Neutron sensors

PGRS

Gamma-ray sensors

Field sensors

## OBJECTIVE

- Test the response of mobile ground-based gamma sensor over an agricultural plot of 400 $m^2$ (Stop and Go)
- Spatial and Temporal variability of SWC under **dry** and **wet** conditions after an event of rain of 16 l.

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# Gamma Radioactivity

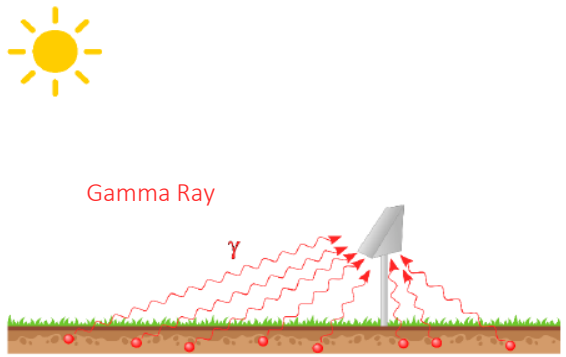
## Nuclear Techniques

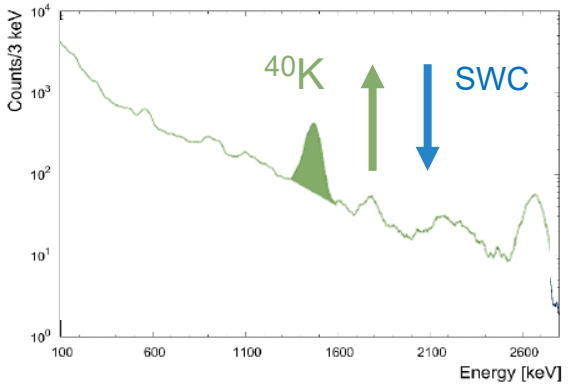
**SOIL WATER CONTENT**

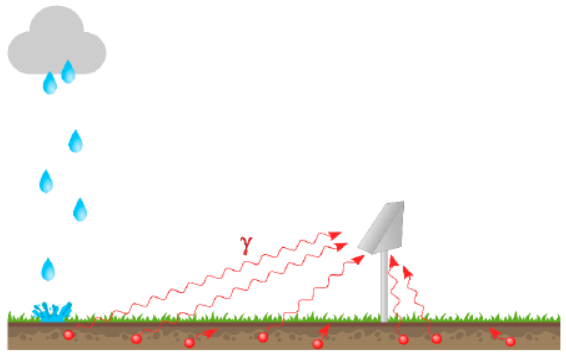
Soil degradation – Soil health - Desiccation - Droughts - CC

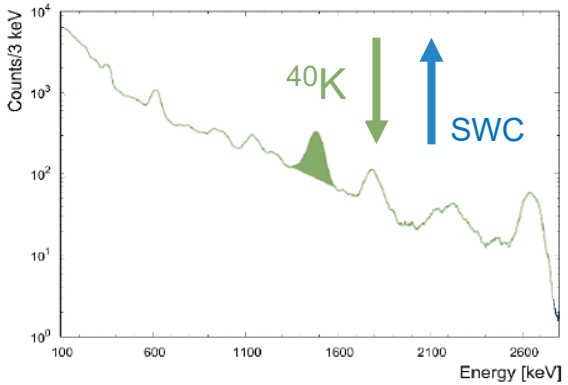
**SOIL EROSION**

$^{40}K$ inversely proportional to SWC



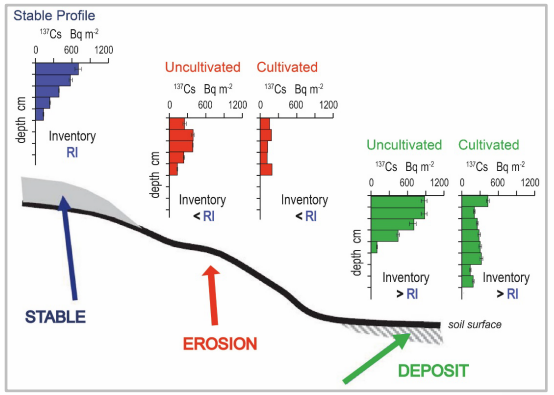



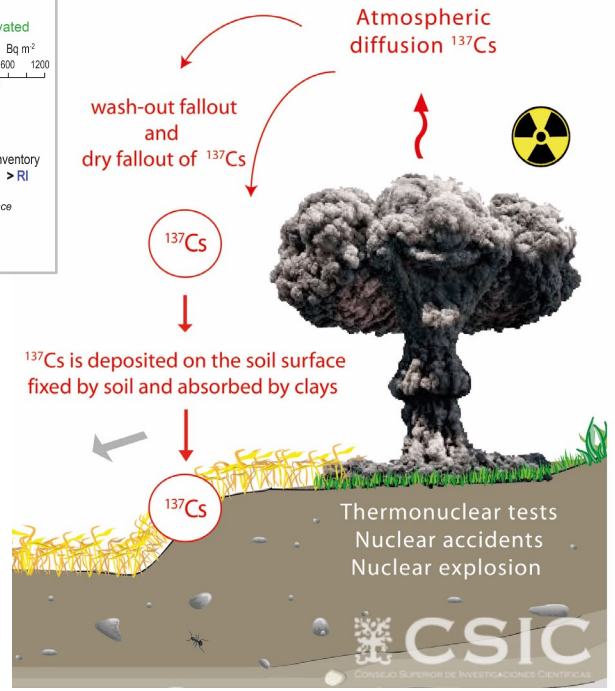




(Serafini et al., 2021)

$^{137}Cs$ radiotracer of soil redistribution




(Gaspar and Navas, 2011)

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# Gamma Radioactivity

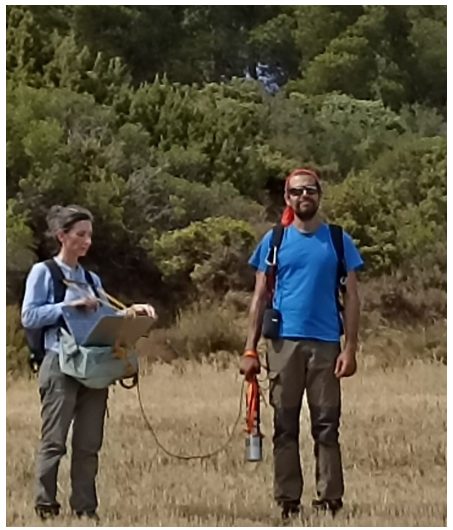
## Nuclear Techniques

**SOIL WATER CONTENT**

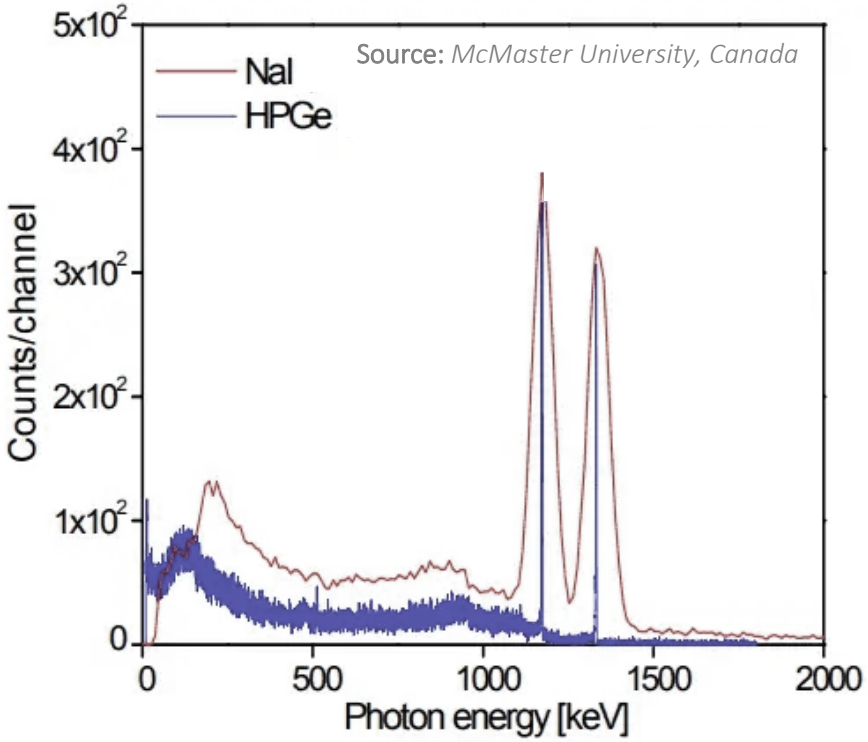
$^{40}K$ inversely proportional to SWC

### NaI detector

- Higher Efficiency
- Lower cost
- Larger Sizes



(Gaspar, L. and Lizaga, I. field survey)




Region of interest:
$^{40}K$ Potassium (1461 KeV)
$^{137}Cs$ Cesium (661 KeV)

**SOIL EROSION**

$^{137}Cs$ radiotracer of soil redistribution

### HPGe detector

- Higher Resolution
- Higher cost

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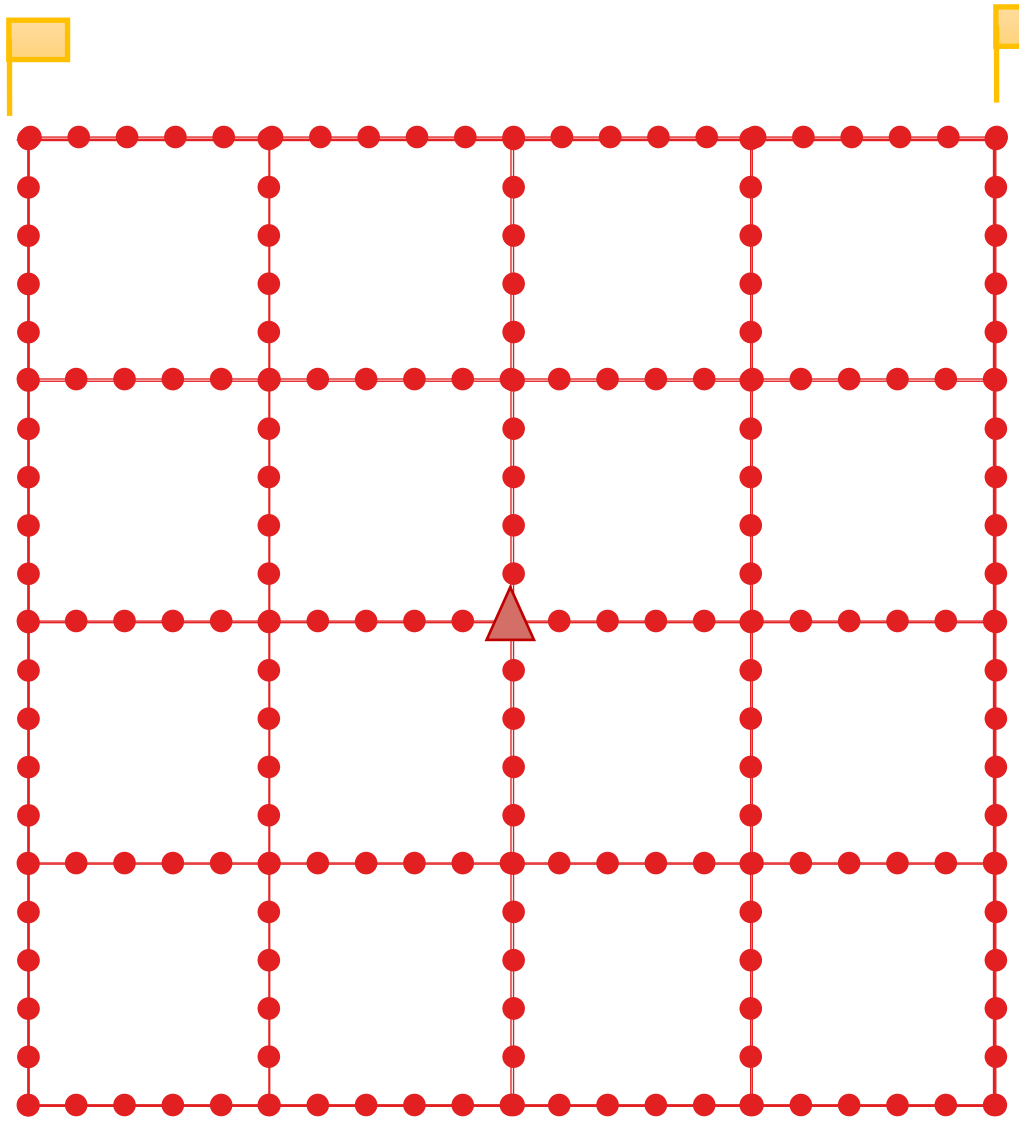
EEAD-CSIC | EESA group. Gamma Lab

# Study Site

## Spain

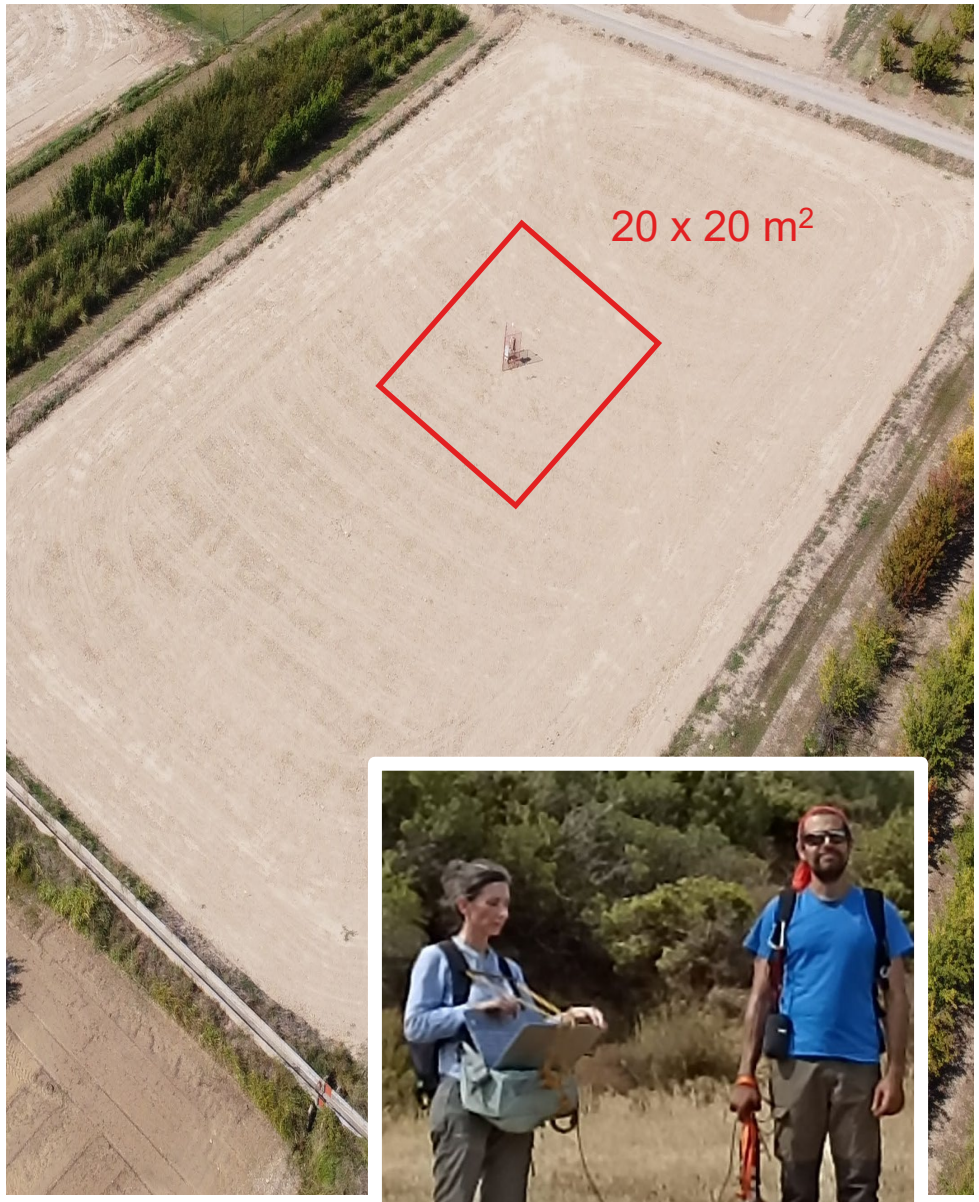
*Aula Dei Experimental Station*
(EEAD-CSIC)
Zaragoza


# Study Design – Stop & GO



Two sets of 5 transects spaced 5m apart placed in a perpendicular direction to cover the plot

Scintillator det.
0.3 L NaI crystal



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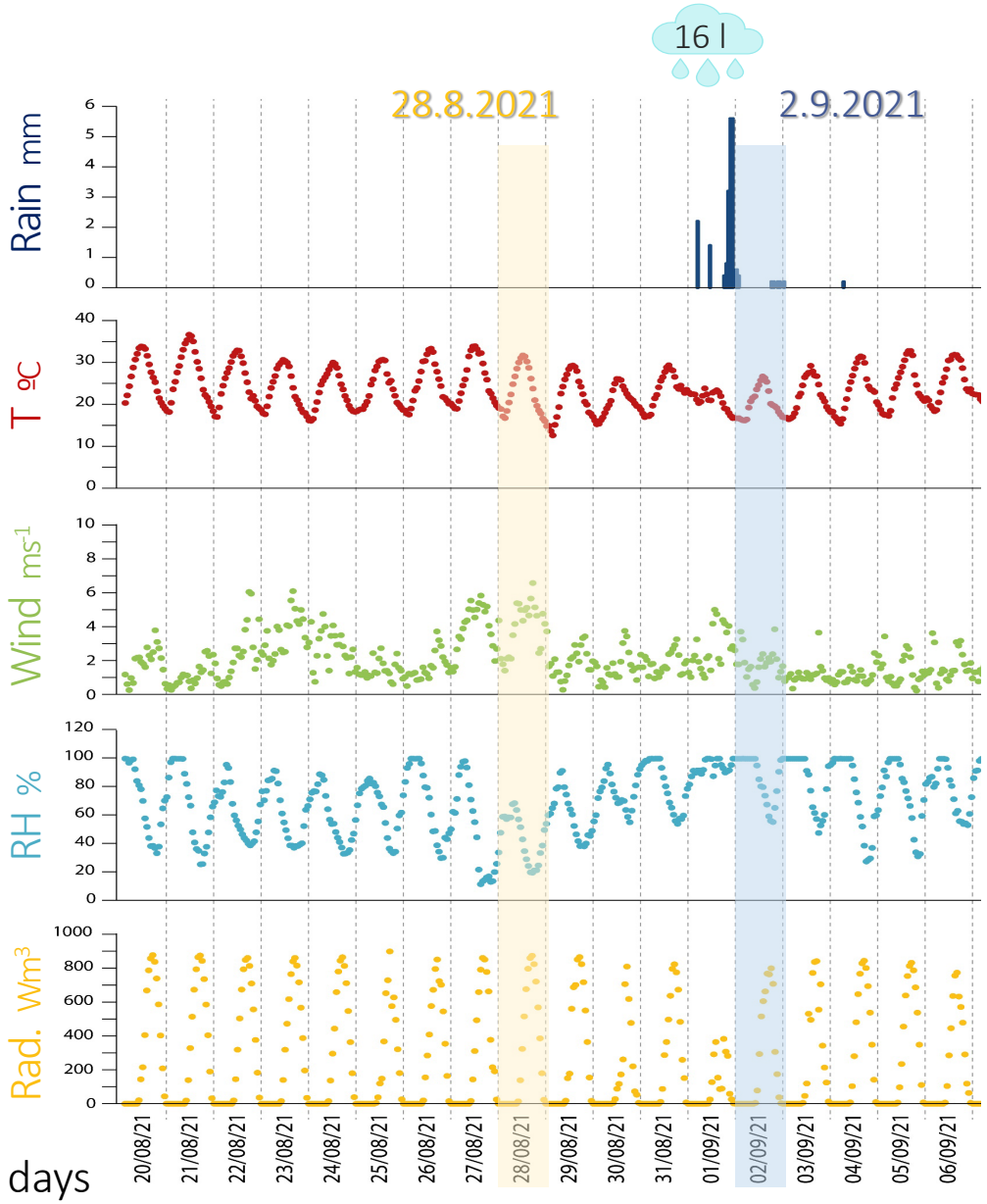
# Study Design – 2 surveys



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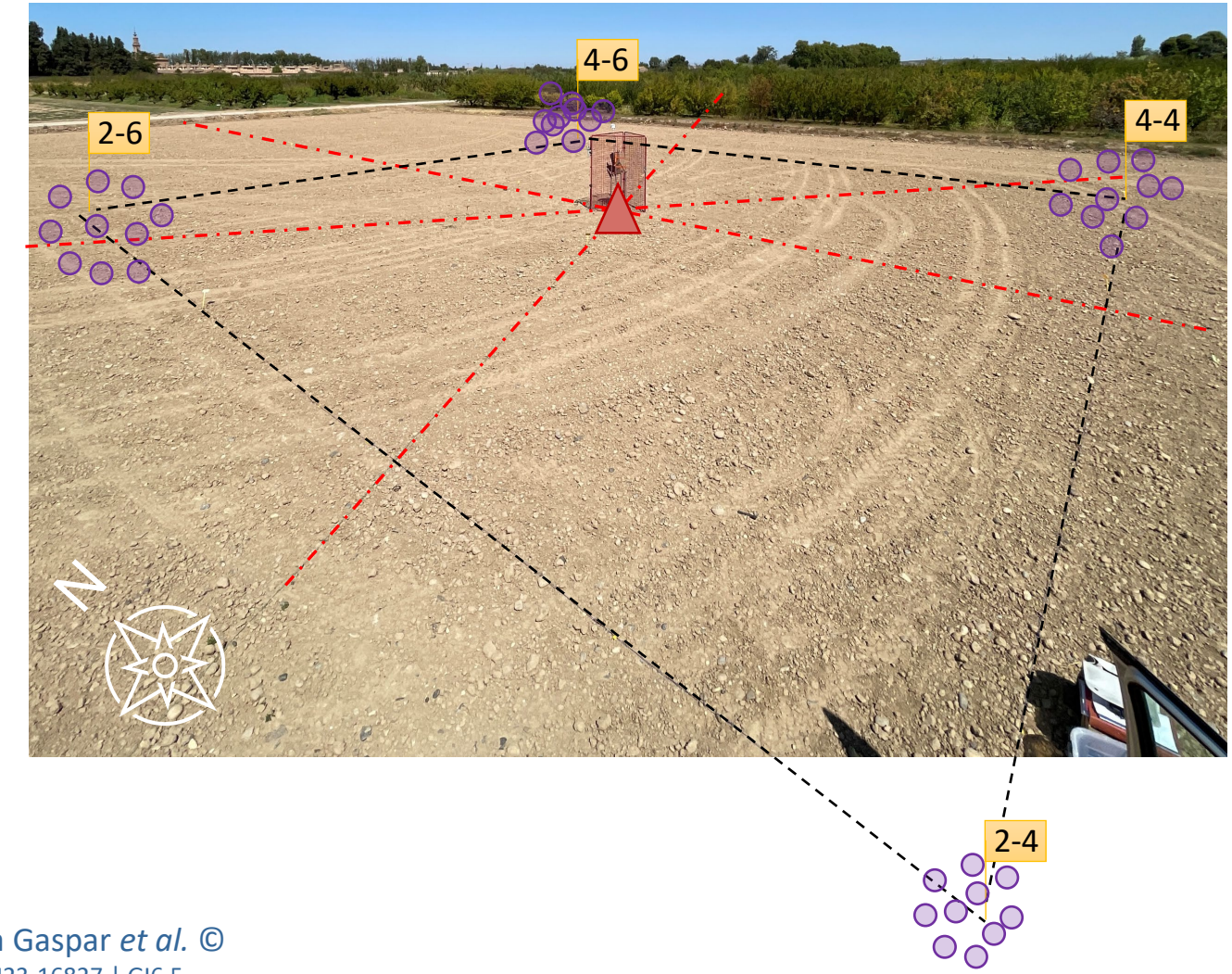
# Methodology


Soil Samples for the characterization of the field

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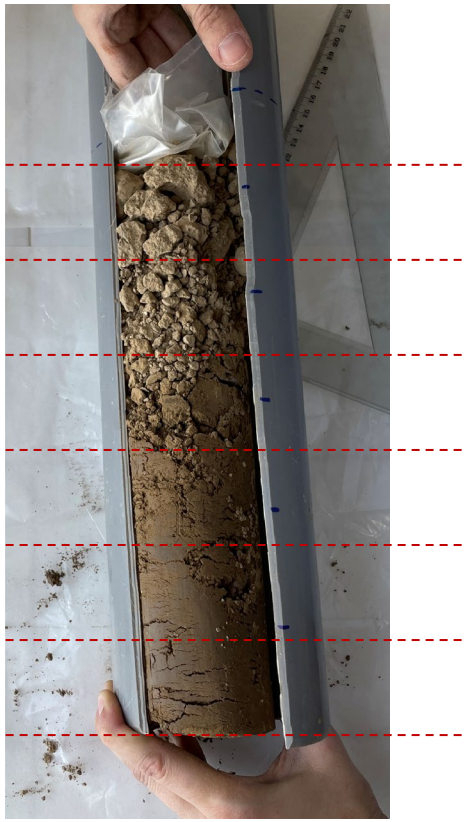
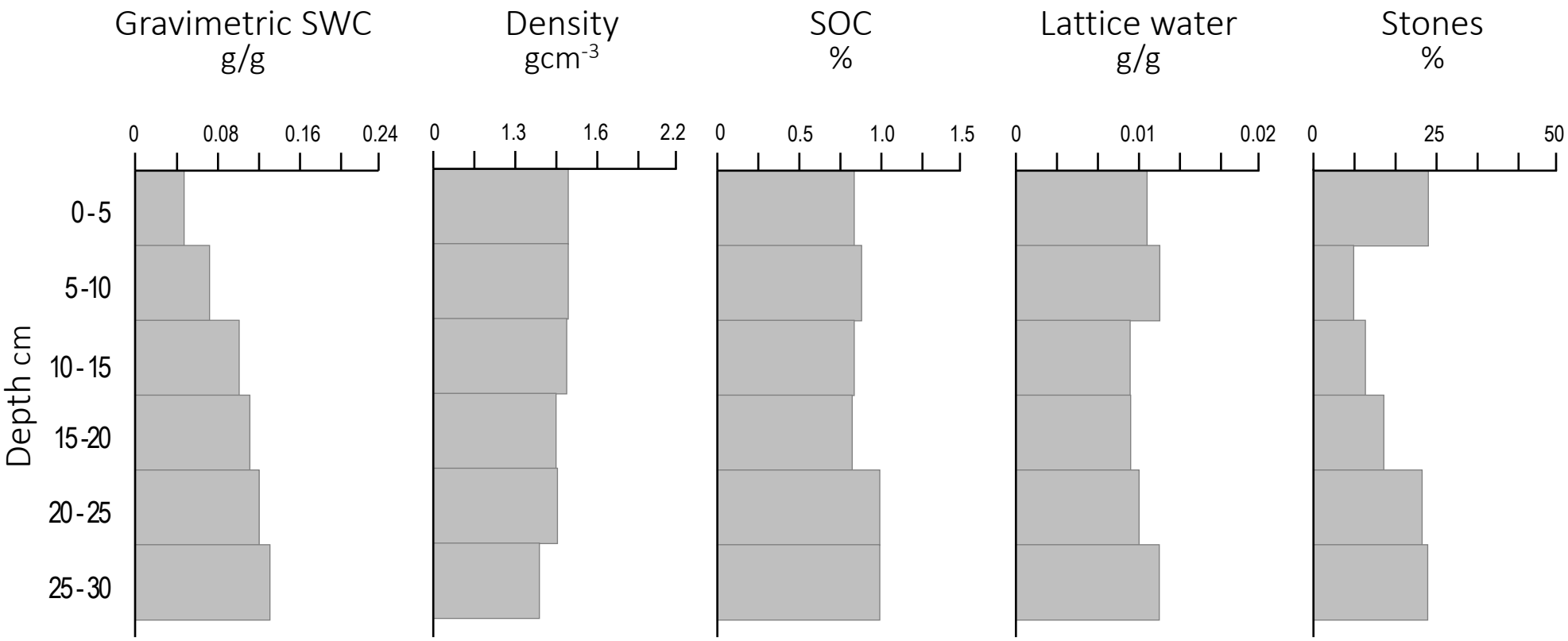
# Methodology

## Sectioned profiles






| | Gravimetric SWC | Density | SOC | Lattice water | Stones |
|---|---|---|---|---|---|
| *mean* | 0.120 | 1.325 | 0.96 | 0.010 | 14.3 |
| ± *S.D* | ± 0.03 g/g | ± 0.225 gcm$^{-3}$ | 0.07 % | 0.000 g/g | 5.9 % |

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# Methodology - Gamma

2 m diameter
30 cm depth

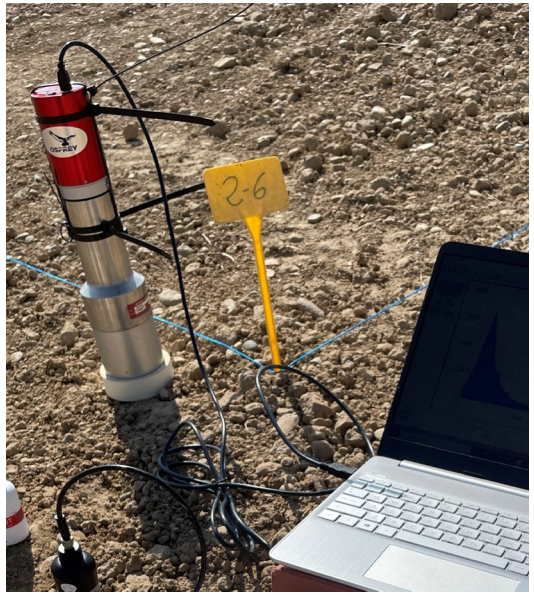
## Scintillation detector

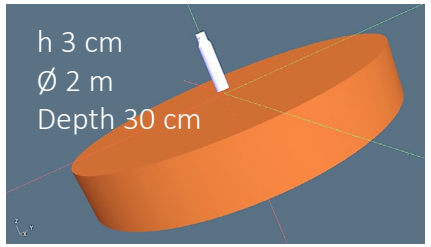
**NaI(Tl)**

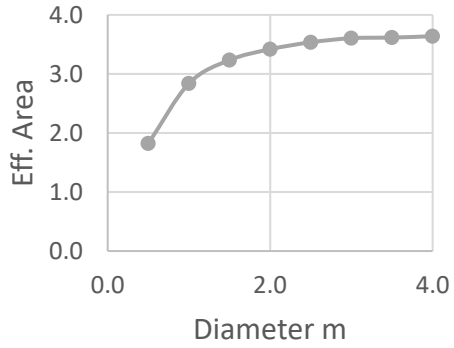
High light output and energy resolution

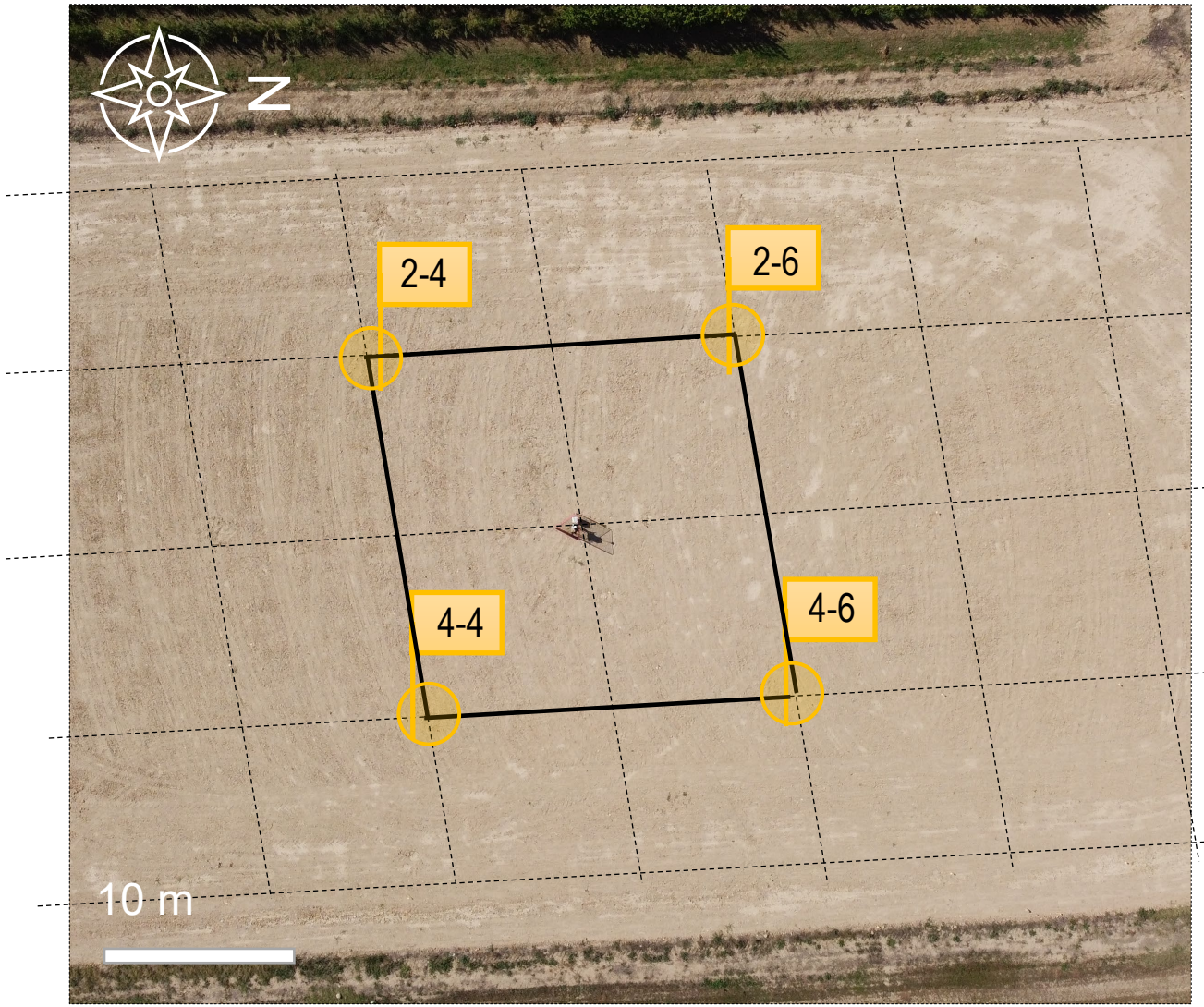
*Osprey*® digital **MCA** from Mirion

High-voltage power supply (HVPS), fully-integrated multi-channel analyzer (MCA) tube base that contains everything needed to support scintillation spectrometry.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# Methodology - CRNS

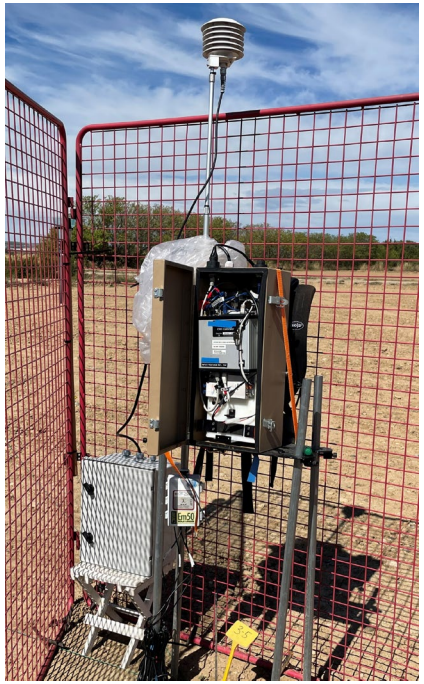
50 m diameter
30 cm depth

## Cosmic Ray Neutron Sensor

**CRNS backpack**

Non-invasive, passive, mobile and measure soil moisture over an area of 100m and the top 30 cm

Hydroinnova




*Equipment loaned thanks to the collaboration with Franz, T.*

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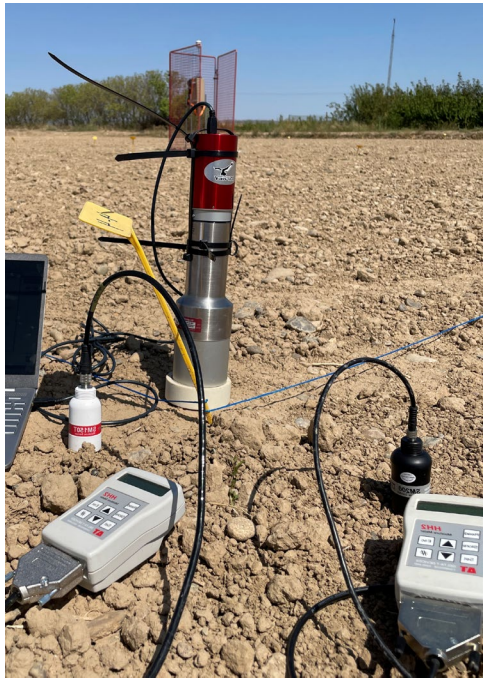
# Methodology - Field sensor

Data point - 10 data/site
5 cm depth

- Soil Moisture Delta-T
  **SM200** Field sensor
  In-situ soil moisture probes for the top 5 cm



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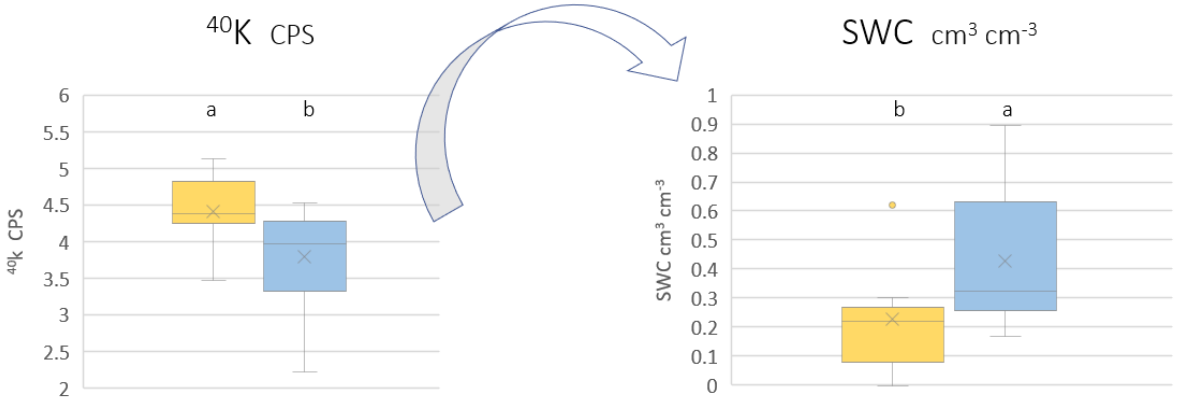
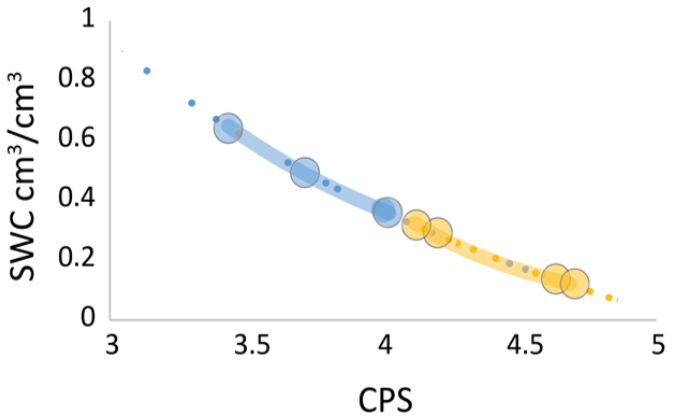
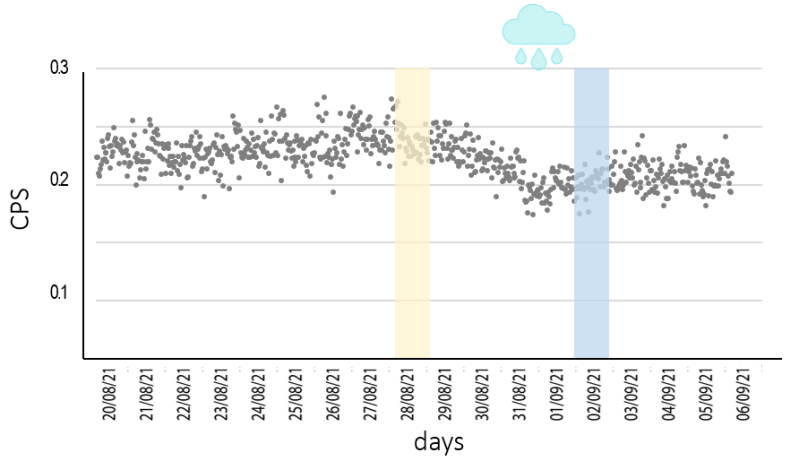
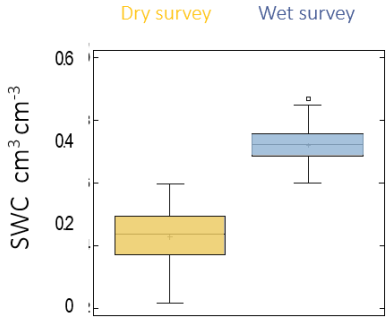
# Results

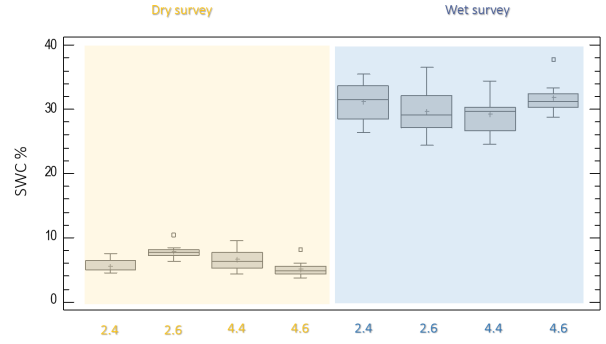








Dry survey 28.8.2021

Wet survey 2.9.2021

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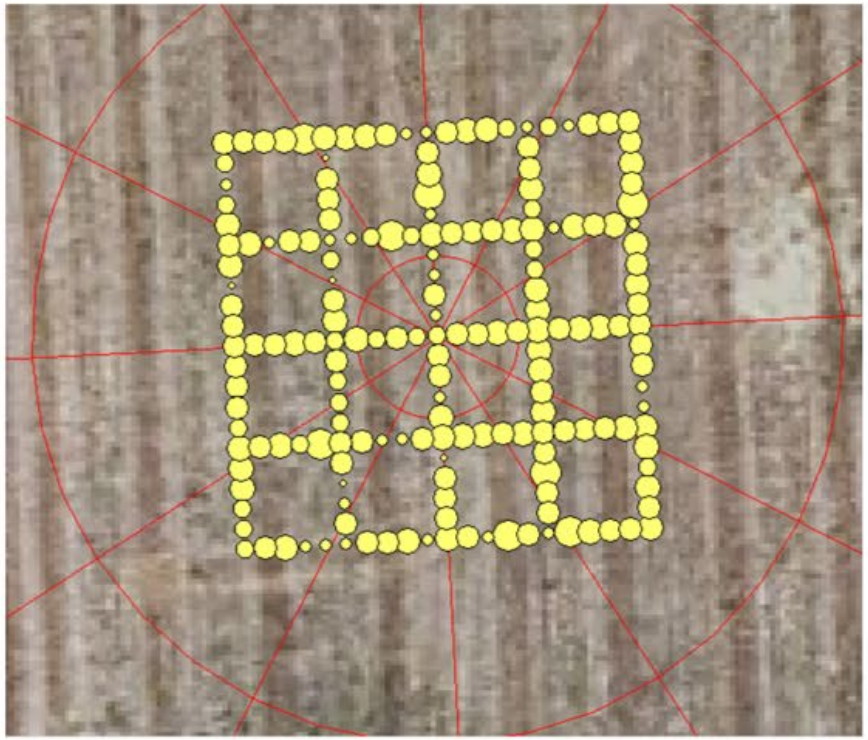
# Results

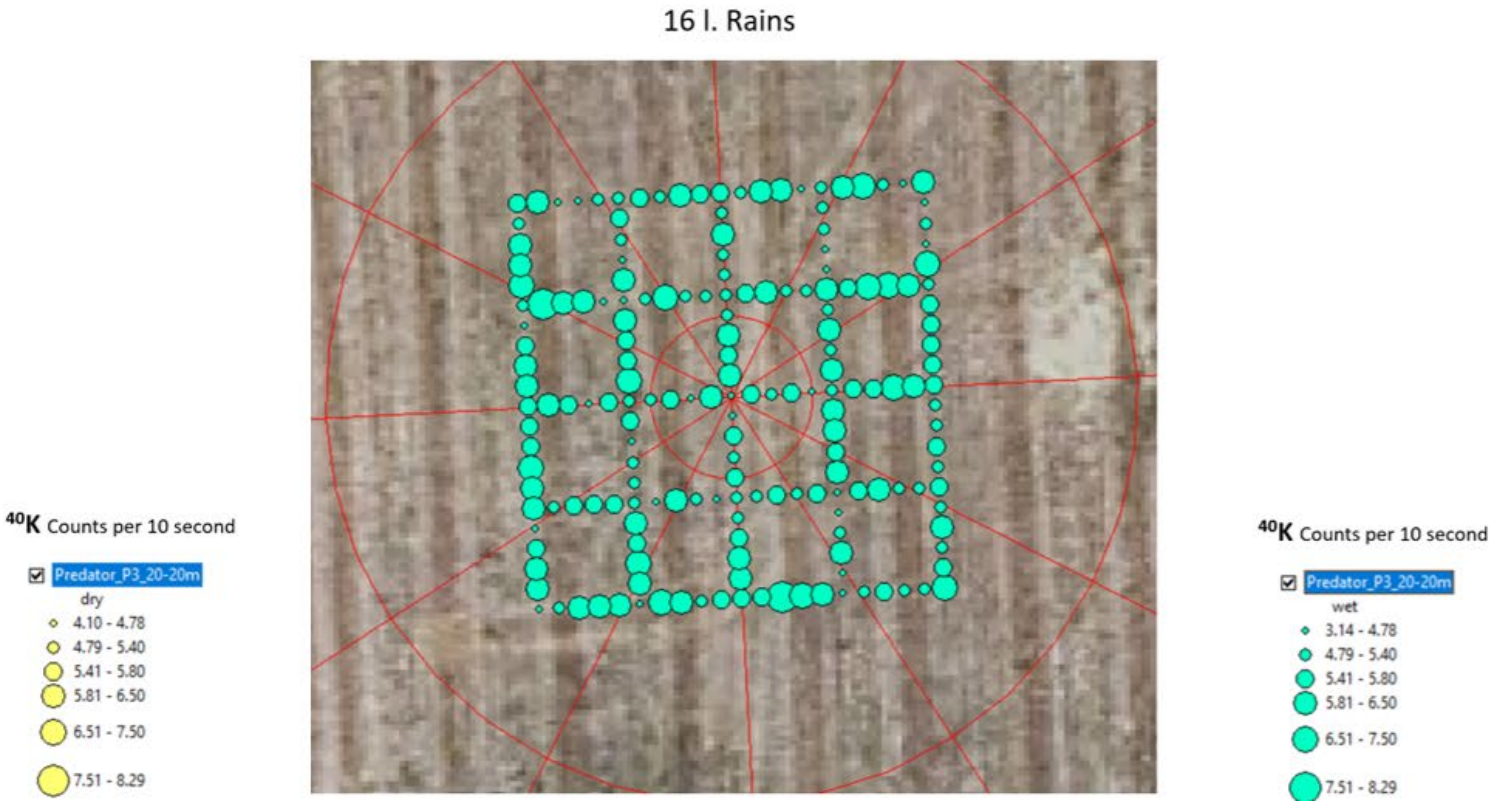
16 l

Dry survey 28.8.2021

Wet survey 2.9.2021

- Mobile measurements were conducted 0.5 m above the soil surface
- Stop-and-go mode (instead on-the-go mode)
- Every 1m, stop for 10 sec





# Results

16 l

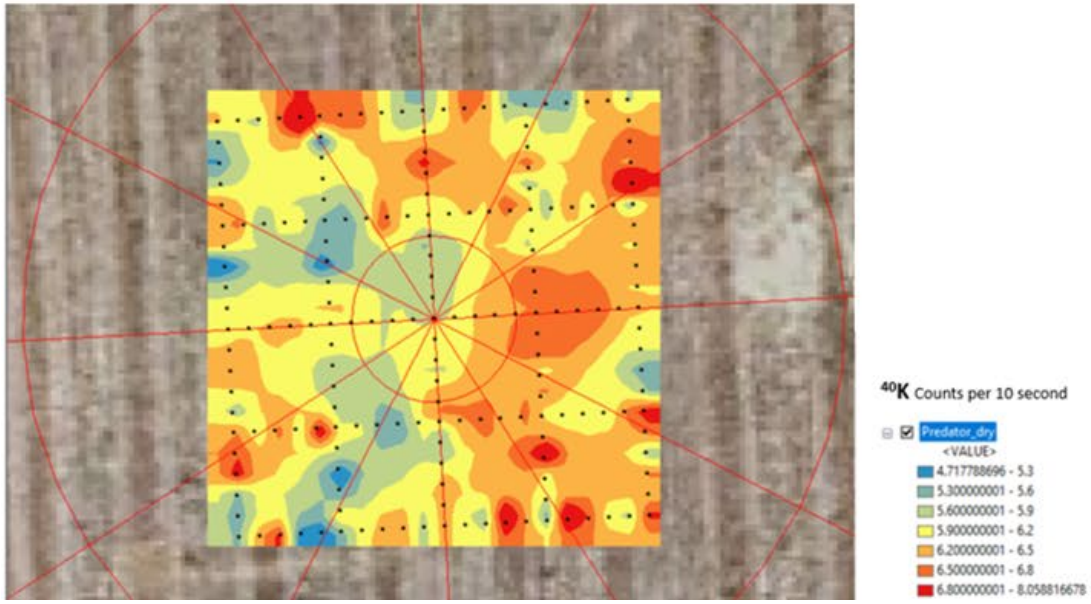
Dry survey 28.8.2021

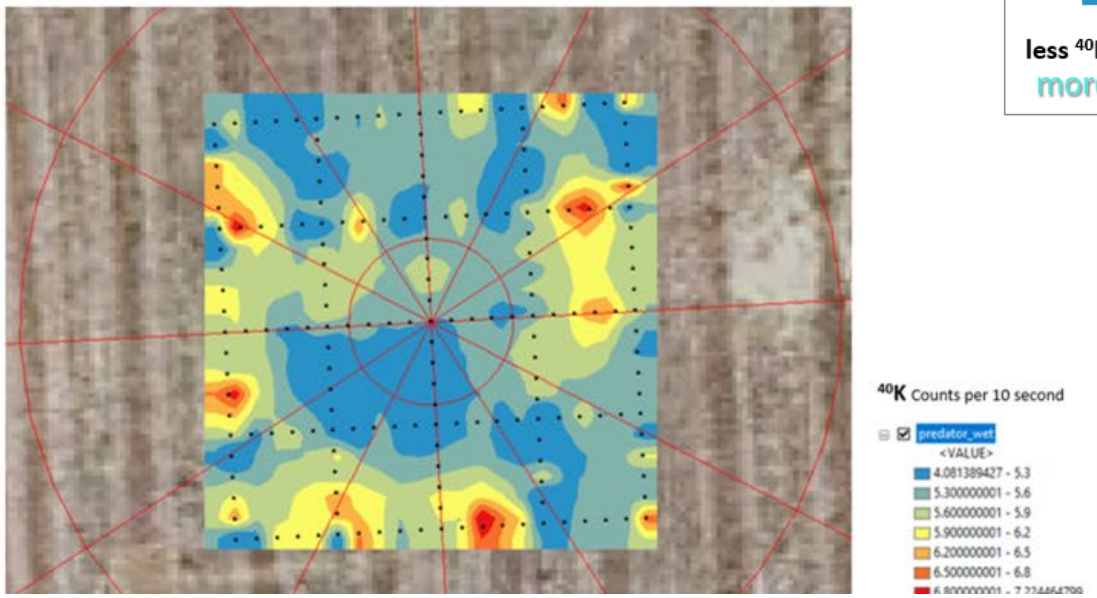
Wet survey 2.9.2021

- Total of 21 measurements per transect, obtaining 210 data for geostatistical interpolation.
- Preliminary results show higher content of $^{40}K$ (cps) during the dry compared to the wet survey
- Also some differences in the spatial distribution of $^{40}K$ for both surveys.
- Similarities and parallel trends were observed when comparing mobile and stationary measurement, ssupporting the promising use of PGRS technique.

**more $^{40}K$ Counts**
more DRY

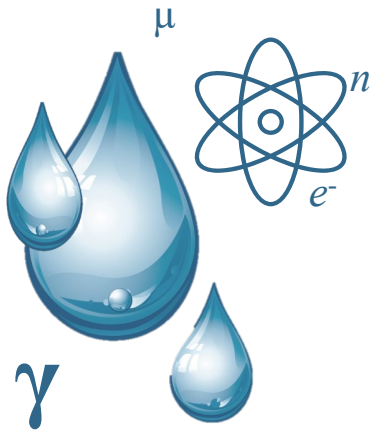
**less $^{40}K$ Counts**
more WET

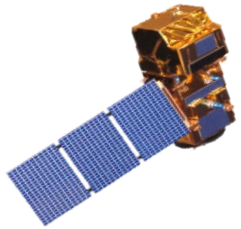


# Message to take Home

- Preliminary results with PGRS in Spanish soils
- PGRS high sensitivity to the different status of soil moisture responding to 16 l. event (dry-wet conditions)
- Good comparison between SWC estimated by PGRS, CRNS and volumetric field sensors
- Proximal gamma-ray spectroscopy is an effective technique for monitoring the spatial and temporal distribution of terrestrial radioelements like $^{40}K$
- Highligh the promising potential of the use of these nuclear techniques for Spanish agroecosystems and for agricultural purposes



Remote Sensing products

Cosmic-ray Neutron sensors

Gamma-ray sensors

Field sensors

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# Thank you for your Attention

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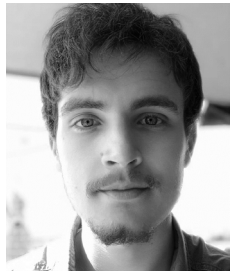

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