Session 4. [STSA] May 19; Mon 17:00
Session Chair: Paulo Estevao Cruvinel

A Prototype of a Monitoring Sensor System for Stored Grains in a Real-world Setting

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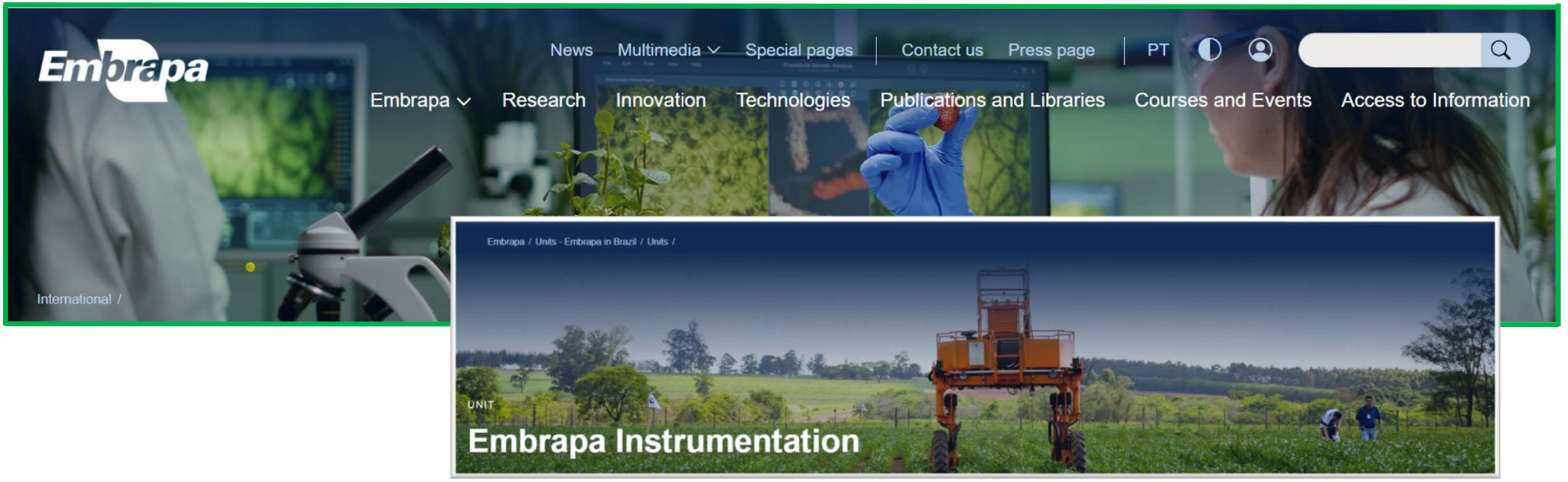
Researcher


BE WELCOME!
CRIAR
Space
SYSTEMS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THE SCOPE


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THE PROBLEM

biological threats
insects, vandals, rodents, omnivorous

biological threats – fungi, yeast

Penicillium – 37.5%

Aspergillus – 22.22%

Fusarium – 16.66%

TOTAL: 76.38%

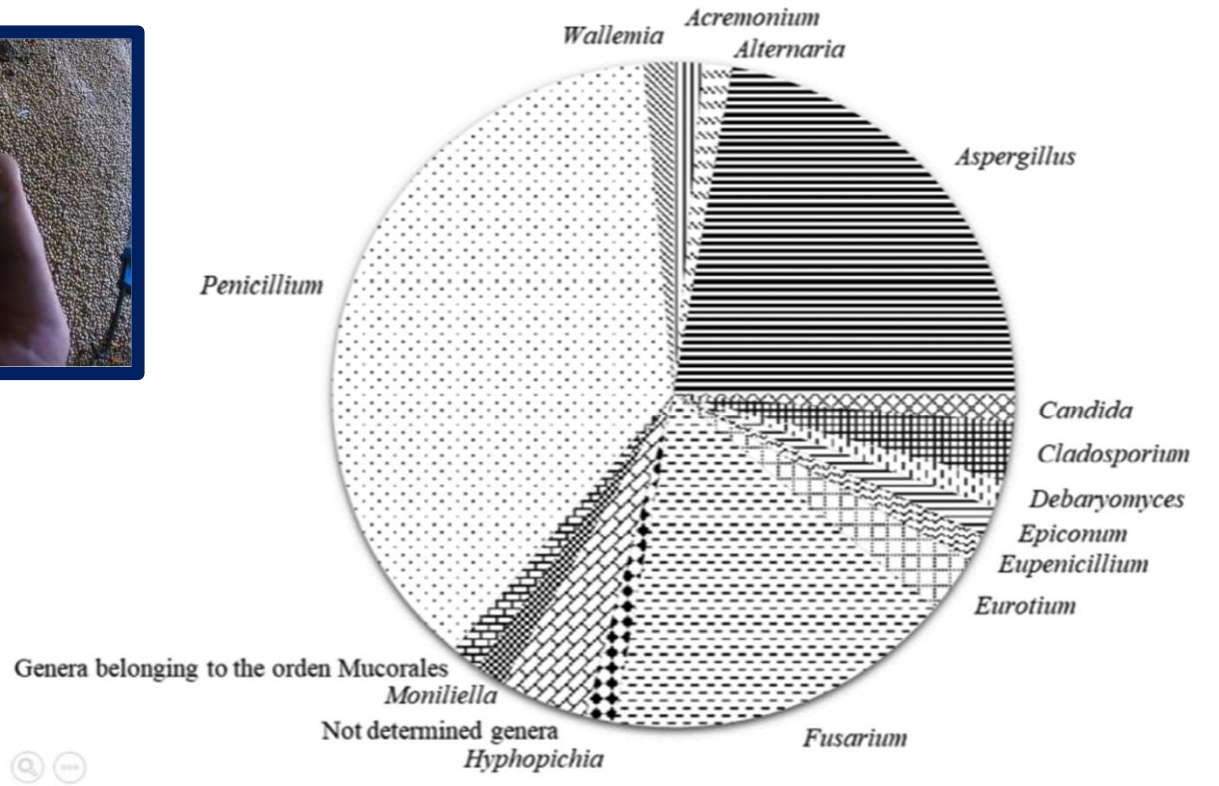


Figure 2. Fungal genus reported in maize stored in silo-bags under different environmental conditions.

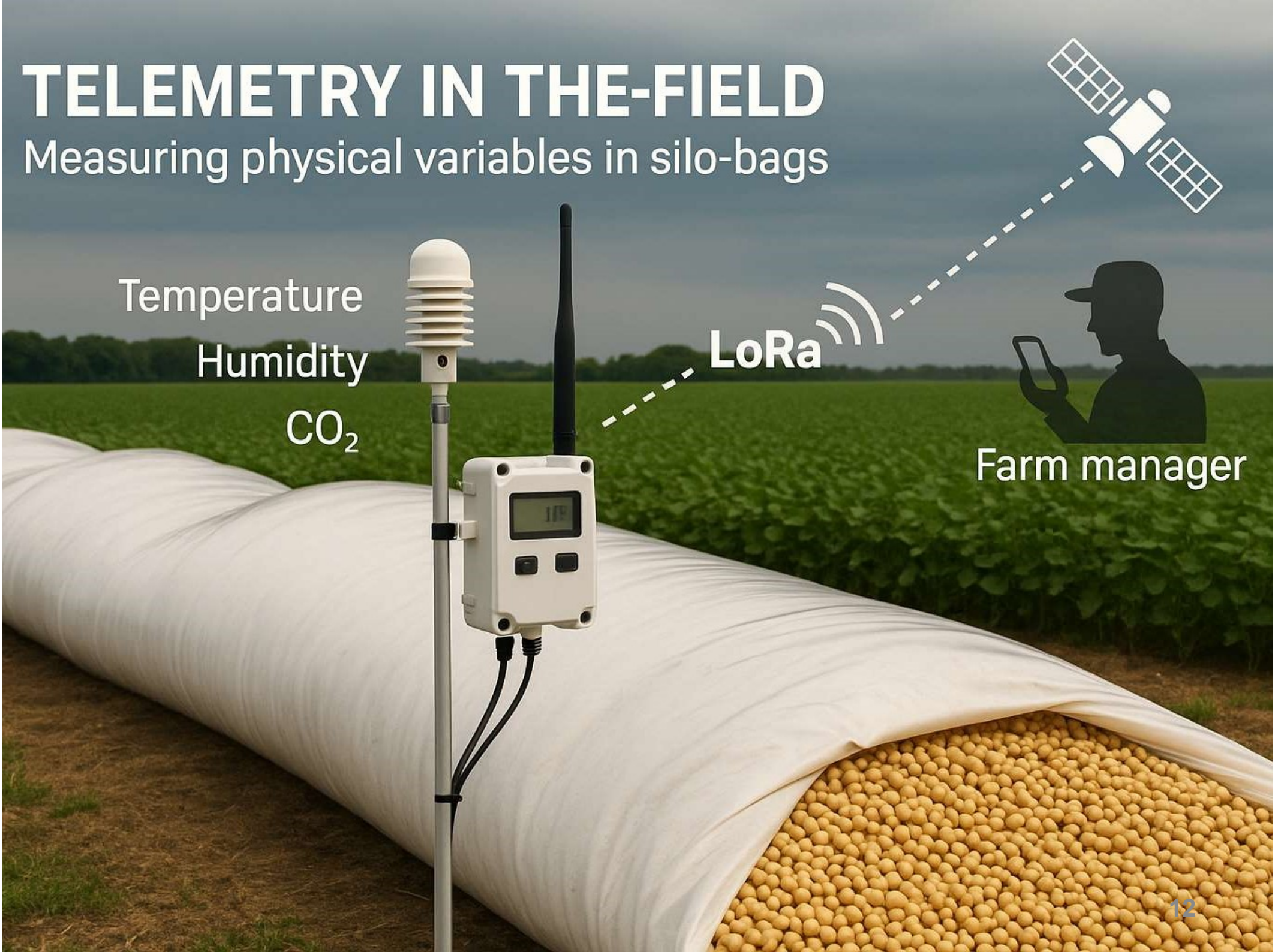
(Brito. 2021)

Atmospheric and substrate conditions for fungal colonization

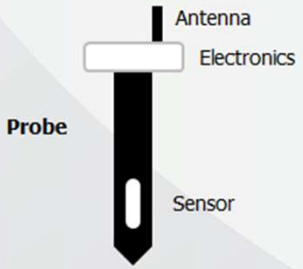
	Penicillium	Aspergillus	Fusarium
Temperature (ºC) better (ºC)	5 a 37 20 a 25	15 a 45 25 a 35	5 a 35 20 a 28
Rel umidity (better)	> 80%	> 70%	> 80%
O2	> 1%	> 1%	> 1%
CO2	< 10%	< 10%	< 10%
pH (better)	5 a 6	5 a 6	5 a 6

1 ppm = 1/1.000.000 = 0.0001 %
450 ppm = 0.045 %
10.000 ppm = 1%
21% = 210.000 ppm

THE PROJECT


TELEMETRY IN THE-FIELD
Measuring physical variables in silo-bags
Temperature
Humidity
CO_2
LoRa
Farm manager

Monitoring storage systems becomes a viable alternative to reduce the risk of most types of accidents.



Probe schematic. The probe is composed of sensors, conditioning electronics, and antenna.

Ground communication network is formed by probes installed in the silos, a hub (data concentrator) coupled to a ground station that transmits the signal to the satellite.

Encapsulation of electronic circuits for signal condigioning and transmission

Sensors

Filtro de Data: 2024-11-01 - 2024-11-01

Empresa: Embrapa

Filtrar

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Pesquisar:

ID	Sonda	Temp. Externa (°C)	Temp. Interna (°C)	Umidade Externa (%)	Umidade Interna (%)	CO2 Interno (%)	Bateria (%)	Data Leitura
79830	63	24.37	28.95	48.41	54.82	2.29	73.48	2024-11-01 0(
79831	64	24.56	27.62	46.18	62.53	2.16	74.97	2024-11-01 0(
79832	65	25.59	28.69	47.66	61.84	2.59	50.45	2024-11-01 0(
79833	63	23.16	28.73	49.21	54.93	2.27	74.60	2024-11-01 01
79834	64	23.71	27.65	46.48	62.54	2.14	74.22	2024-11-01 01
79835	65	25.08	28.61	48.05	61.98	2.57	50.82	2024-11-01 01

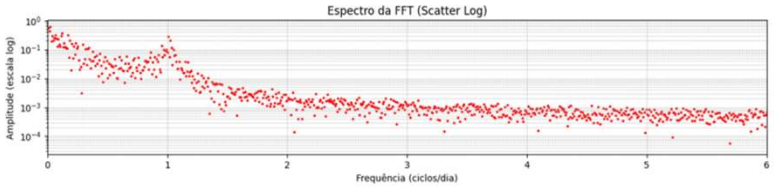
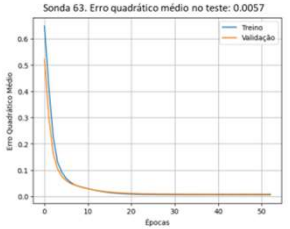
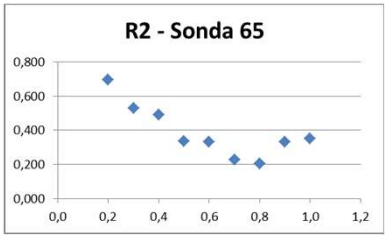
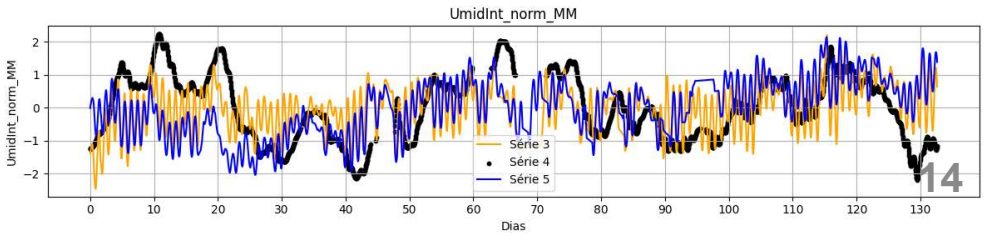


tabela de variância explicada por cada componente

	PC1	PC2	PC3	PC4
SONDA 65	0,488	0,282	0,188	0,042
SONDA 64	0,437	0,276	0,239	0,048
SONDA 63	0,466	0,352	0,148	0,034





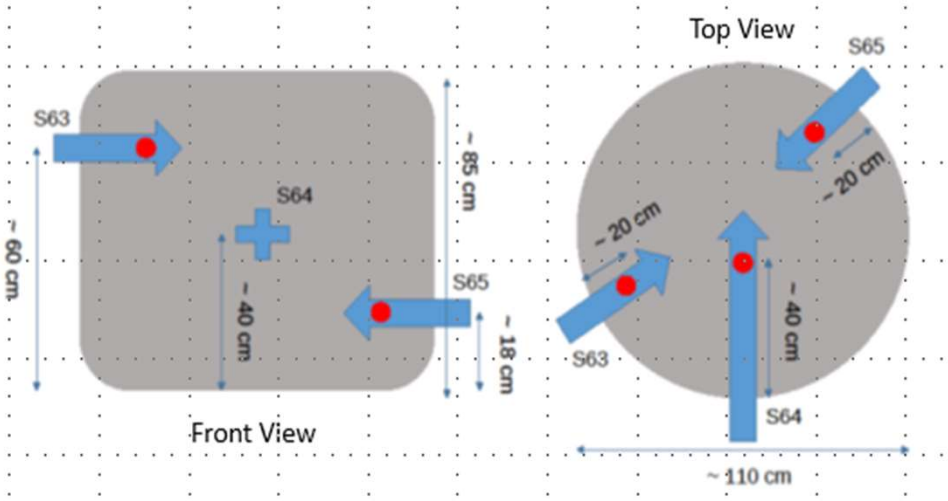


IS THERE A CORRELATION BETWEEN THE VARIABLES?

IS THE POSITION OF THE PROBE RELEVANT?

IS THE DEPTH OF THE SENSOR RELEVANT?

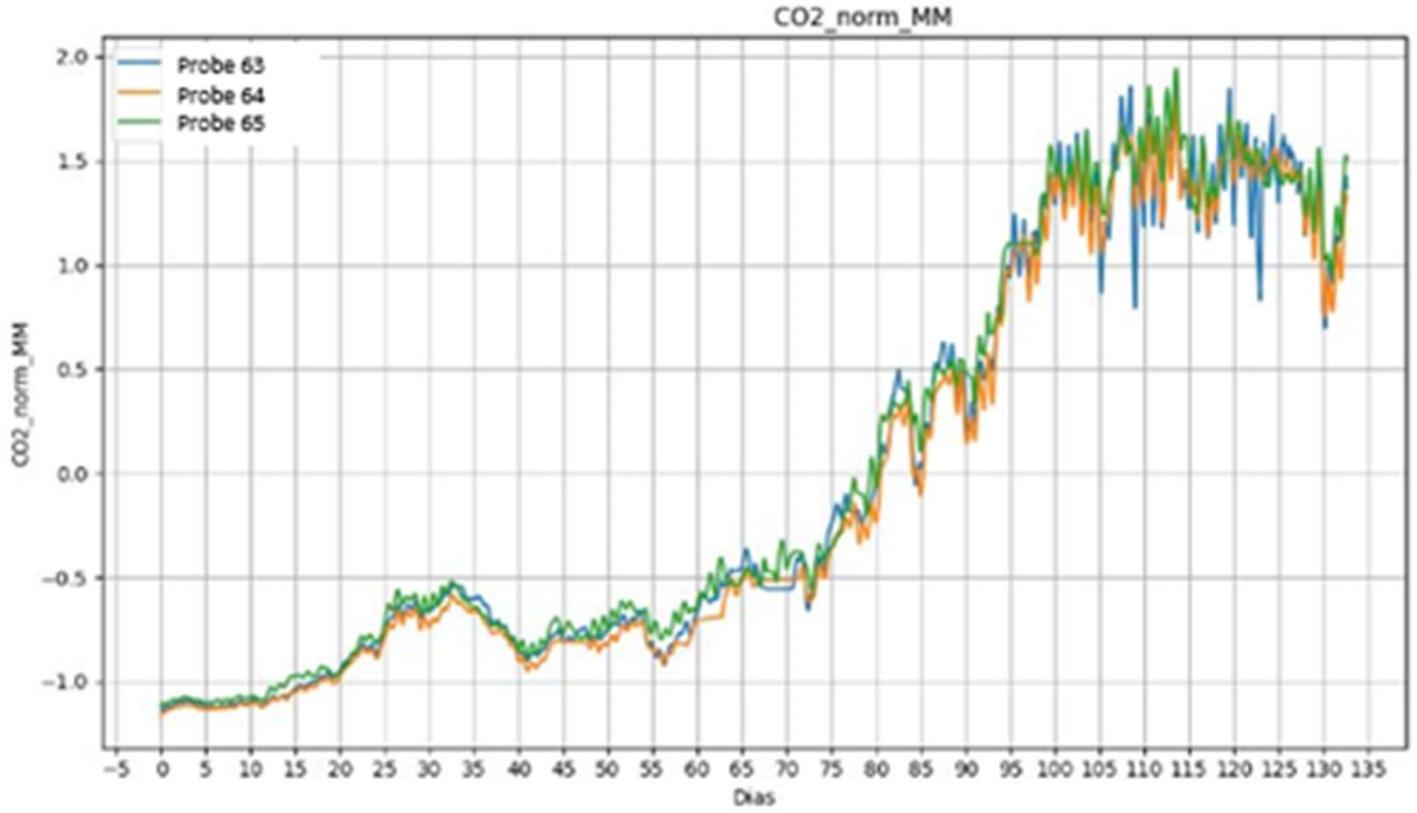
THE EXPERIMENT



Temperature internal
Umidity internal
CO2 internal

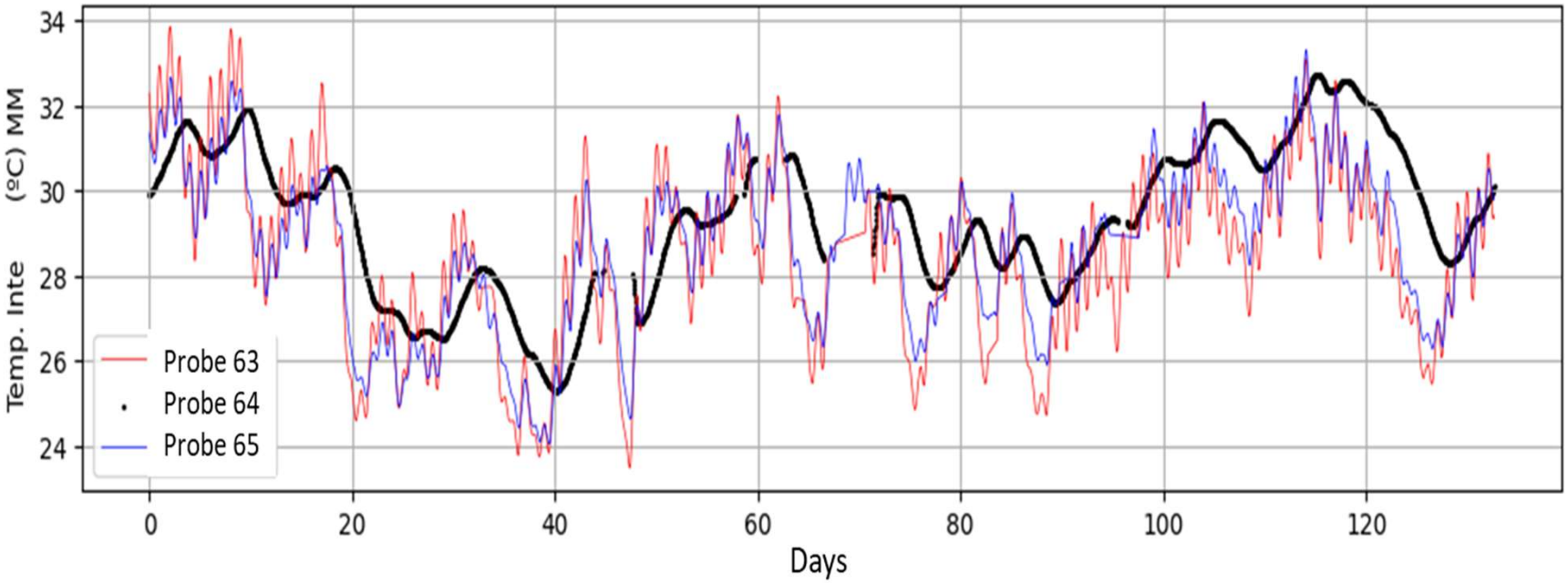
Temperature external
Umidity external

CO2 concentration
Simple Moving Avarage 12; 3 Probles



Could CO_2 become a bulk indicator of the internal environment of the silo?

Internal Temperature
Simple Moving Avarage 12; 3 Probes



The position of the probe
—both along the surface of the silo and in terms of depth—
is relevant

PROBE 63	Temp. Ext (ºC)	Umid Ext (%)	Temp. Int (ºC)	Umid Int (%)	CO2 Int (%)
Temp. Ext (ºC)	1,00	-0,90	0,32	-0,81	0,01
Umid Ext (%)	-0,90	1,00	-0,54	0,82	0,10
Temp. Int (ºC)	0,32	-0,54	1,00	-0,23	0,05
Umid Int (%)	-0,81	0,82	-0,23	1,00	0,19
CO2 Int (%)	0,01	0,10	0,05	0,19	1,00

PROBE 65	Temp. Ext (ºC)	Umid Ext (%)	Temp. Int (ºC)	Umid Int (%)	CO2 Int (%)
Temp. Ext (ºC)	1,00	-0,67	0,34	-0,49	-0,01
Umid Ext (%)	-0,67	1,00	-0,72	0,28	0,29
Temp. Int (ºC)	0,34	-0,72	1,00	0,30	0,24
Umid Int (%)	-0,49	0,28	0,30	1,00	0,51
CO2 Int (%)	-0,01	0,29	0,24	0,51	1,00

It is necessary to develop a dedicated study to understand:

the effect of the probe's position on correlation;

the correlation of CO_2 in different internal environments

Conclusions & Future studies

1. IS THERE A CORRELATION BETWEEN THE VARIABLES?
   "Yes, a correlation was observed, although its magnitude was less than anticipated.
   However, this is a complex issue that involves confounding variables

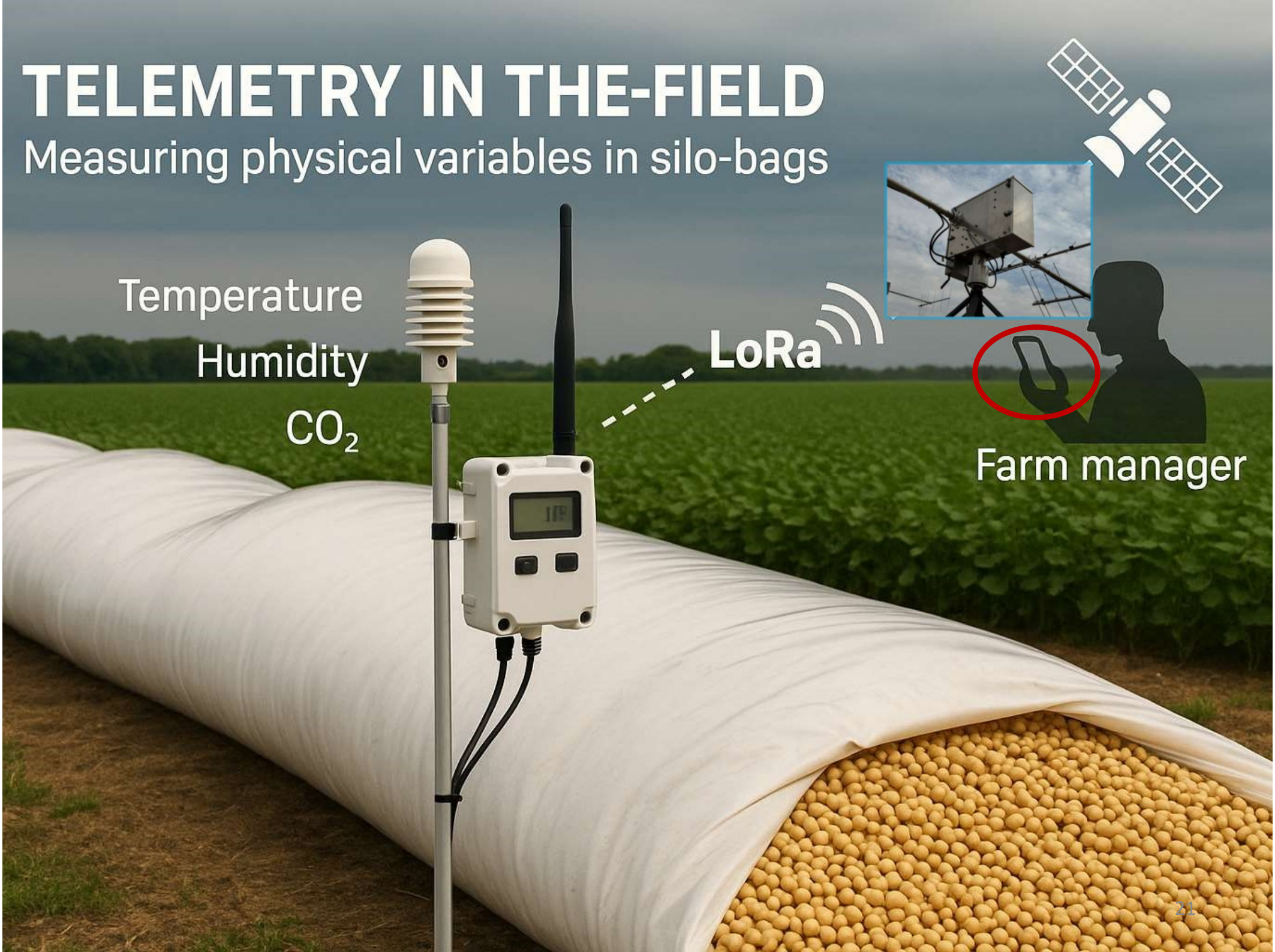
2. IS THE POSITION OF THE PROBE RELEVANT?
   Yes, its position is relevant because the constraints differ accordingly

3. IS THE DEPTH OF THE SENSOR RELEVANT?
   Yes, a 20 cm depth has a significant impact.
   This is attributed to the thermal characteristics of the grain and the conductivity of the granular medium

4. DATA ANALYSIS, DATA MINING, AND MACHINE LEARNING ARE PROMISING TOOLS FOR ACHIEVING THE PROJECT'S OBJECTIVES

5. DESPITE THE PROJECT'S IMMEDIATE DATA SCIENCE CHALLENGES, THE INSTRUMENTATION WILL CONTINUE TO BE IMPROVED

6. THE STUDY VALIDATED THE PROOF OF CONCEPT OF THE MEASUREMENT AND DATA TRANSMISSION SYSTEM IN A RELEVANT ENVIRONMENT AND PAVED THE WAY FOR FIELD-SCALE TESTING.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AKNOWLEDGEMENTS