



Ricardo Teixeira

Professor Ricardo Teixeira is an Assistant Professor at the University of Lisbon and co-founder of the startup VirtuaCrop

Panel 3

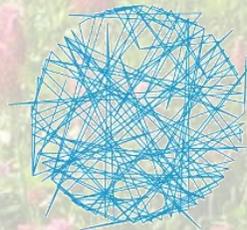
Vienna Soil Dialogue
23/03/2026

3. Innovation & Metrics – What Works on the Ground and How Do We Measure It?

Soil system monitoring for engineered pasture systems

Ricardo F.M. Teixeira

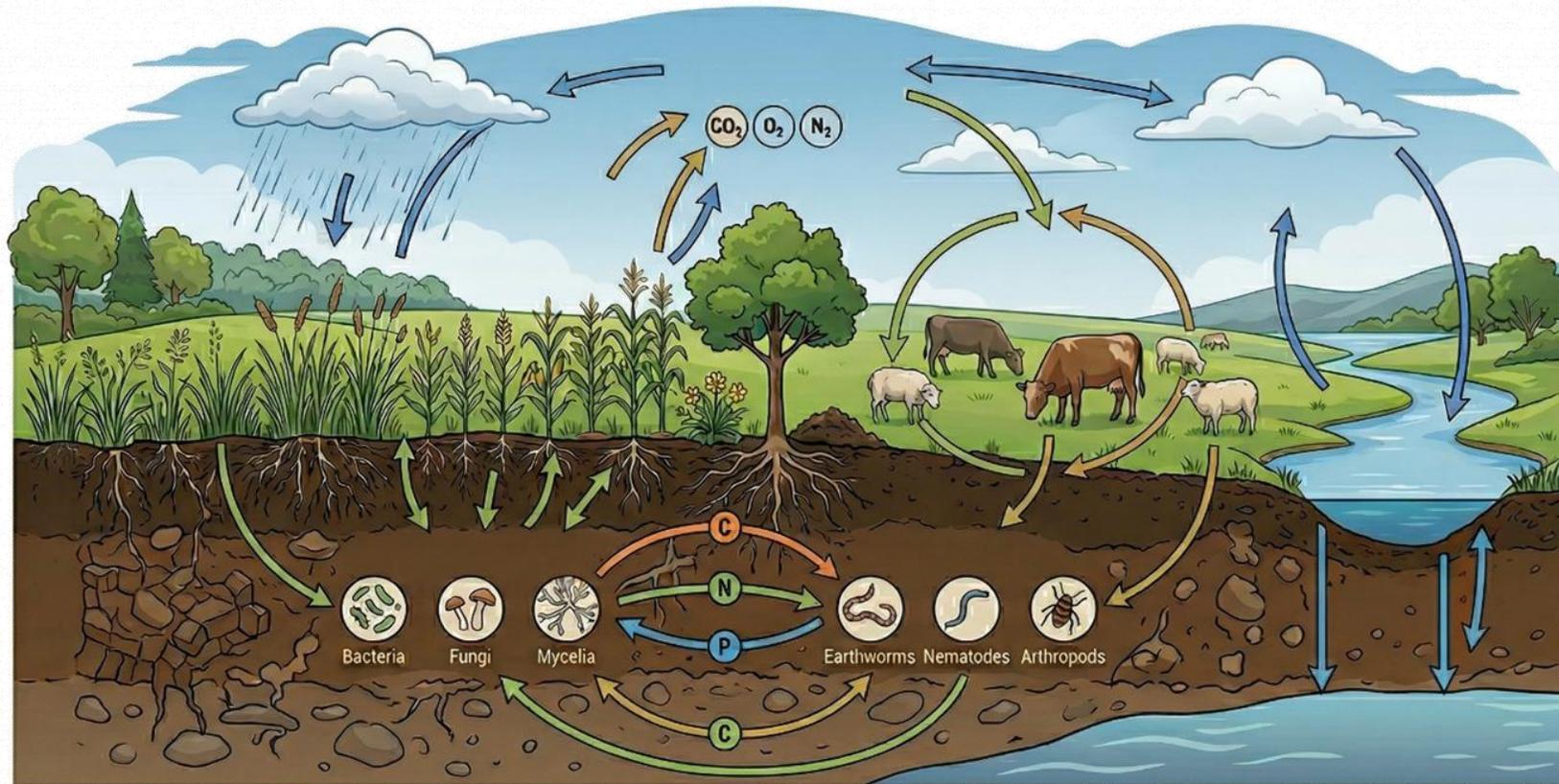
MARETEC, LARSyS, Instituto Superior Técnico & IST-ID, University of Lisbon, Portugal



LARSyS
Robotics and Systems in
Engineering and Science



From soils to "soil systems"



What does “regenerative” mean?

nature

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NEWS FEATURE | 09 September 2025

A revolution is sweeping Europe’s farms: can it save agriculture?

Momentum is building for regenerative agriculture, a set of approaches that could help farms to weather the changing climate and make them more profitable.

Did you know that regenerative farming does not have to mean only traditional management, but also engineered systems?

Sown Biodiverse Pastures (SBP)

A biodiversity engineering innovation



Permanent, as they are self-reseeding and can be maintained for at least 10 years (in some cases 25 years)

Sown, because high-yield native species are introduced into the pasture

Biodiverse, because up to 20 species or varieties of plant seeds are used

Rich in legumes, because many species are legumes that sequester nitrogen from the atmosphere and avoid the use of additional fertilizer

Each hectare of SBP

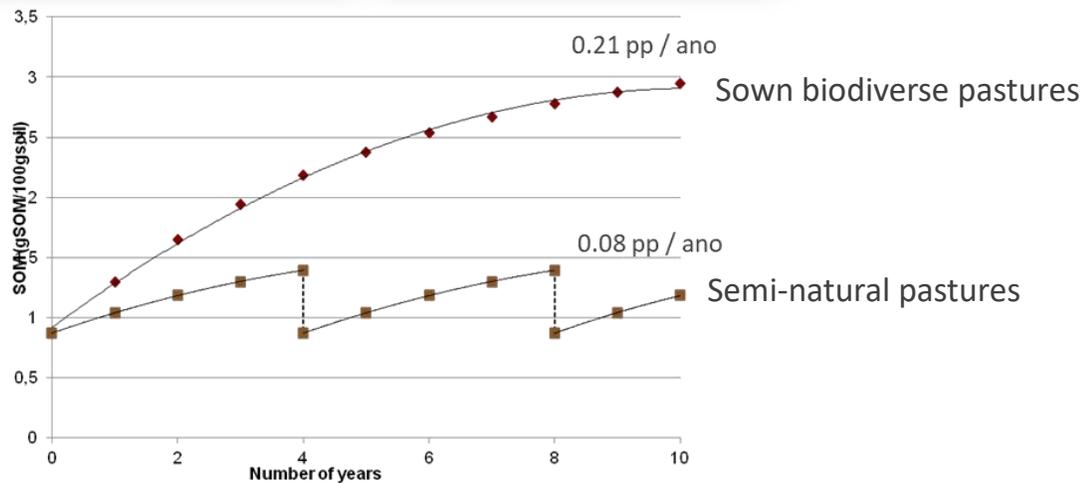
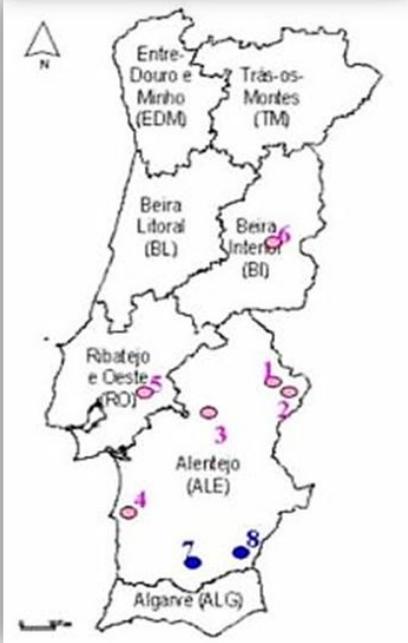
- Avoids the use of approximately 0.5 hectares of farm land
(Higher yield -> Less concentrate feed consumption)

Carbon sequestration potential



Soil organic matter dynamics in Portuguese natural and sown rainfed grasslands

R.F.M. Teixeira^{a,*}, T. Domingos^a, A.P.S.V. Costa^b, R. Oliveira^b, L. Farropas^b, F. Calouro^b, A.M. Barradas^c, J.P.B.G. Carneiro^c



10-year average: 6,5 tCO₂/ha/year

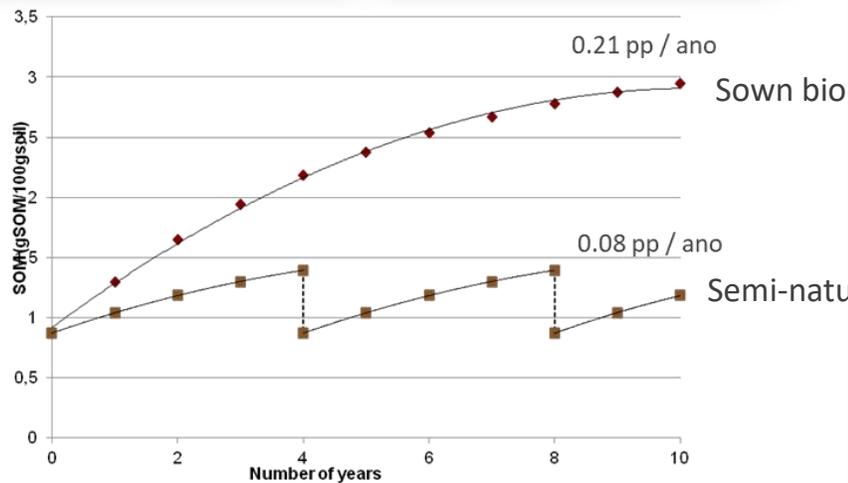
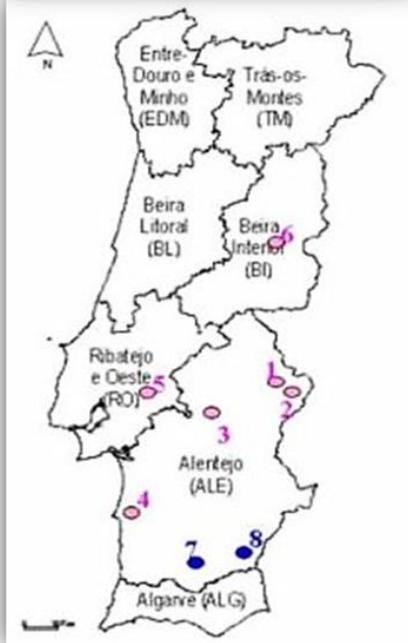
Teixeira, R. F. M., Domingos, T., Costa, A. P. S. V., Oliveira, R., Farropas, L., Calouro, F., ... & Carneiro, J. P. B. G. (2011). Soil organic matter dynamics in Portuguese natural and sown rainfed grasslands. *Ecological Modelling*, 222(4), 993-1001.

Carbon sequestration potential



Soil organic matter dynamics in Portuguese natural and sown rainfed grasslands

R.F.M.
L. Faro



10-year average: **6,5 tCO₂/ha/year**

Per capita greenhouse gas emissions

Em que países há, em média, por pessoa, mais e menos emissões de gases com efeito de estufa?

Ano: 2016

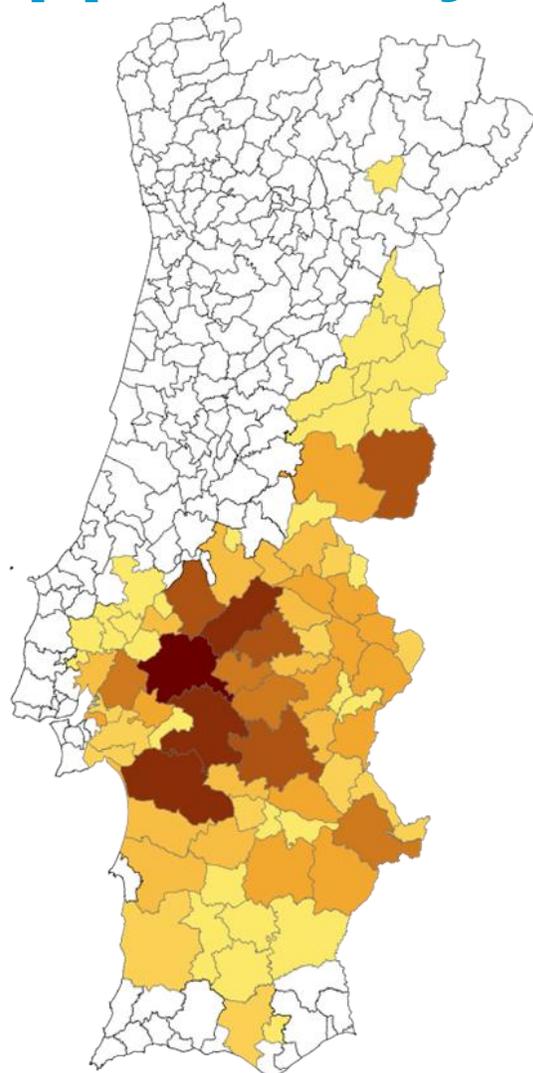
Indicador: Emissões de gases com efeito de estufa

País	2016 (t CO ₂ e...)	1990 (t CO ₂ e...)
UE28	8,4	11,9
Portugal	6,5	6,0

Rank	País	Emissões (t CO ₂ e...)
17	Reino Unid...	7,4
18	Itália	7,1
19	Lituânia	7
20	Espanha	7,4
21	França	6,9
22	Portugal	6,5
23	Hungria	6,3
24	Croácia	5,8
25	Letónia	5,8
26	Roménia	5,7
27	Suécia	5,3

Carregue no gráfico para ver ampliado

Supported by the Portuguese Carbon Fund



Sown Biodiverse Pastures

# Farmers	1 000
Area	50 000 ha
CO₂ sold to Portuguese Carbon Fund	1 Mton
Total amount paid to farmers	6,6 M€

Farmers understood their role as service providers

António Mendes D' Oliveira, (Herdeiros)
AGRICULTURA E PECUÁRIA
Contribuinte n.º 900 606 657
Tel. 045 / 52298 - 52351 - Herdade do Rebôlo
MOSTEIROS - 7340 Arronches

FACTURA
N.º 102
Data **24/09/2010**

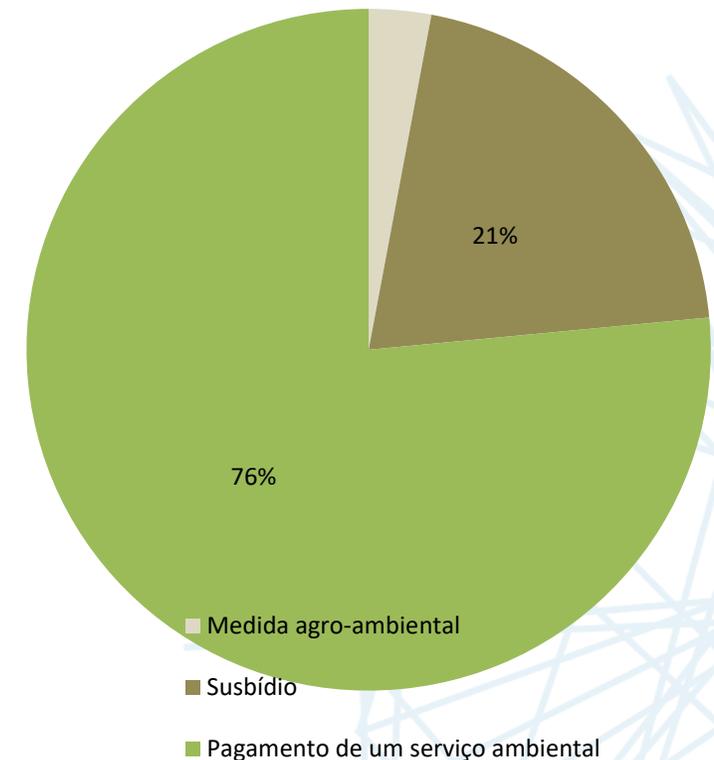
Ex.º Sr. **TERRAPRIMA SERVIÇOS AMBIENTAIS, SOCIEDADE UNIPESSOAL, LDA**
Morada **QUINTA DA FRANÇA**
CONTR. N.º **508759790** VEÍCULO **CARIA**

Quant.	DESIGNAÇÃO	Preço Unit.	IVA Taxa	Importância
19,08	SEQUESTRO DE CARBONO EM PASTAGENS SEHEADAS BIODIVERSAS RICAS EM LEGUMINOSAS - PROGRAMA DE APOIO A PROJECTOS NO PAIS. HECTARES	50,72	21%	967,74 203,22
TOTAL				1170,96

Local de carga **NIB 00456080000000159582** Data / / Hora saída
Local de descarga Data / / Hora prov.

Gráfica Guedelha - Dionísio Guedelha Gordo - R. Lopes Pires, 50-52, Portalegre - Telef. (045) 24423 - Contrib. 807 351 628 - Desp. S. E. A. F. de 88/06/27

Producers see their role as service providers (76%)
rather than receivers of a subsidy (21%)



Supported by the Portuguese Carbon Fund

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CLIMATE ACTION

European Commission

European Commission > Climate Action > Newsroom > Articles

Portuguese project wins World You Like Challenge

08/11/2013

The Portuguese project Sown Biodiverse Pastures has won the European Commission's World You Like Challenge competition for the best solutions to climate change. Connie Hedegaard, European Commissioner for Climate Action, announced the winner at the Sustainia Award Ceremony in Copenhagen last night.

Sown Biodiverse Pastures was crowned overall winner of the Challenge for its innovative approach to reducing CO₂ emissions, soil erosion and the risk of wild fires while increasing the productivity of pasturelands.

ETS regulatory Updates

Roadmap 2050
moving to a low-carbon economy



2014 National winner
of the Energy Globe



2012 Semi-finalista do
concurso Land for Life

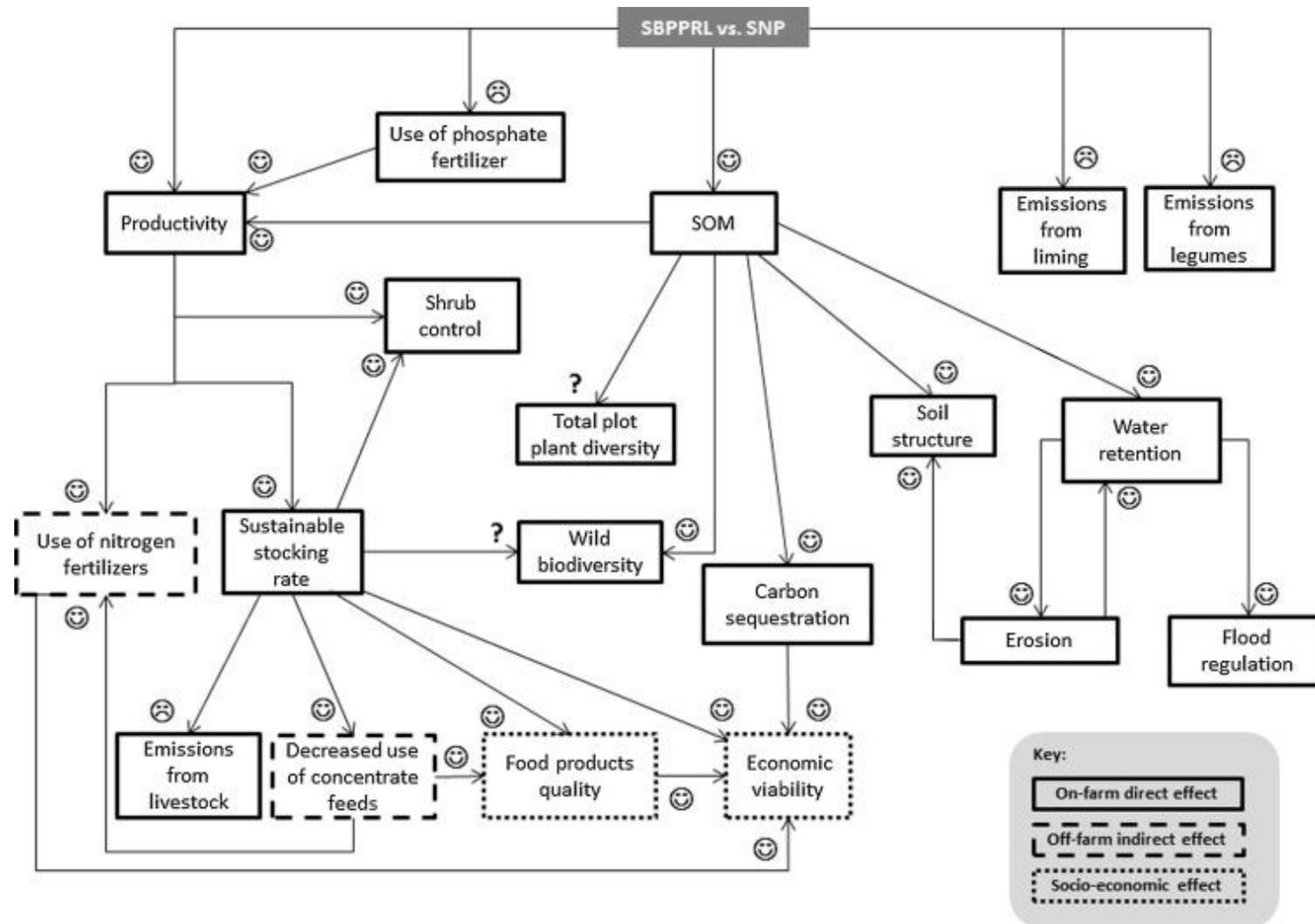


2013 Honoured
Dryland Champion by
the United Nations



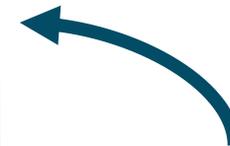
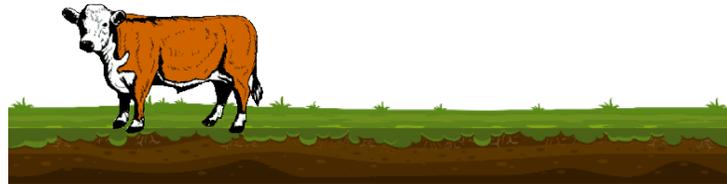
2011 Menção
Honrosa nos Green
Project Awards

How do we manage such a system?

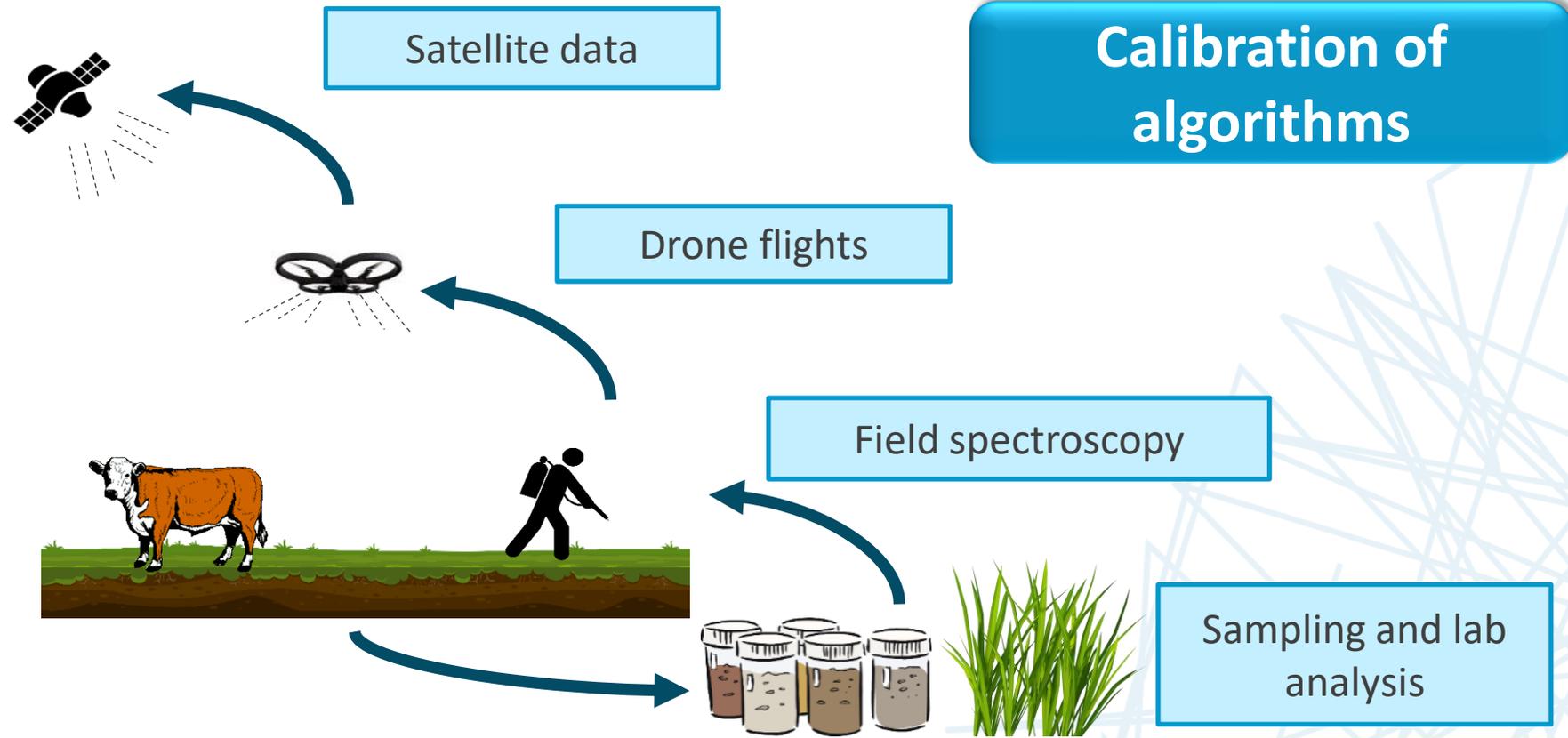


Teixeira, R. F., Proenca, V., Crespo, D., Valada, T., & Domingos, T. (2015). A conceptual framework for the analysis of engineered biodiverse pastures. *Ecological Engineering*, 77, 85-97.

A framework for effective “Agriculture 4.0”



New methods for data acquisition



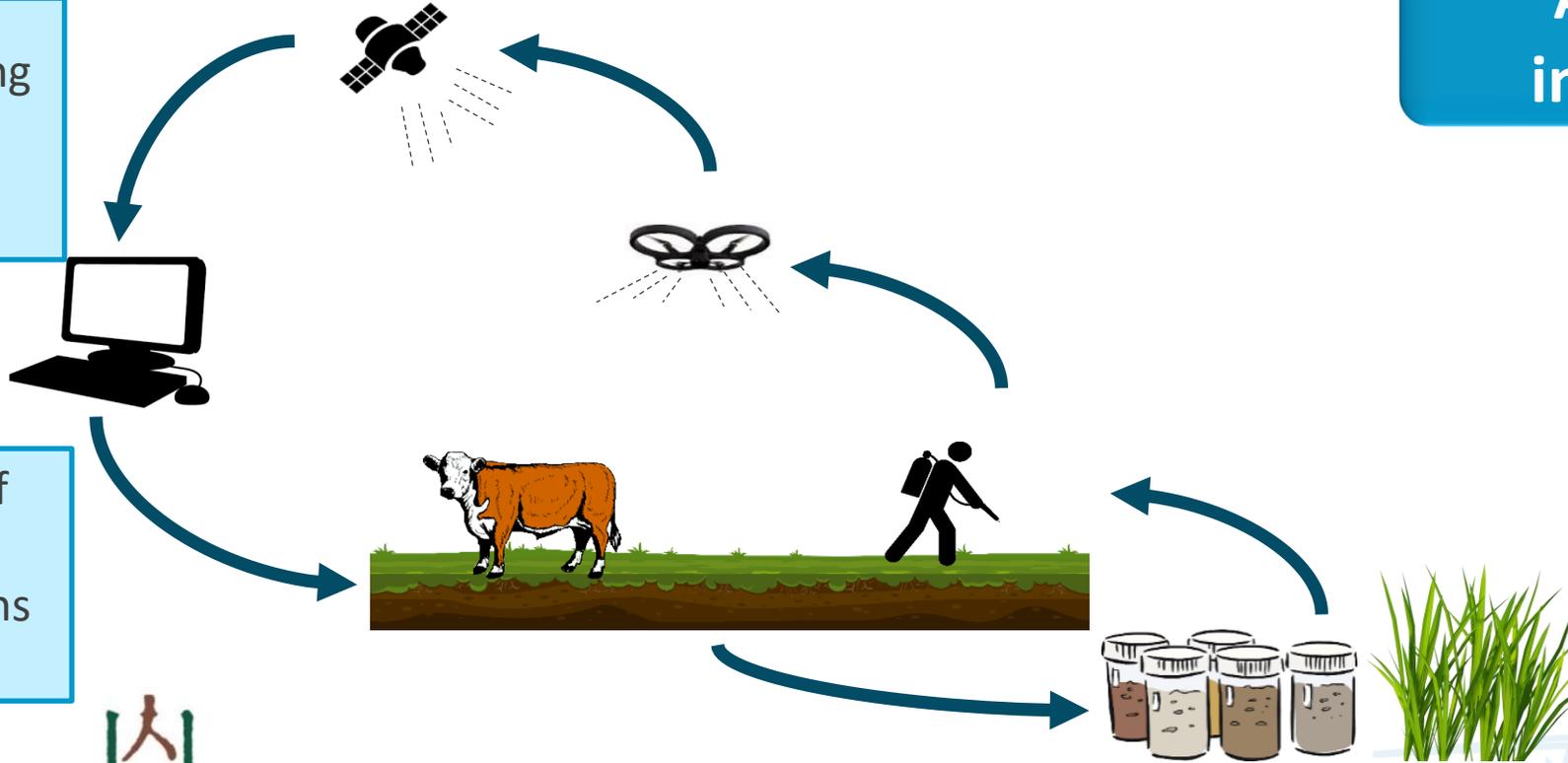
Modelling can help make recommendations

Statistical modelling
+ Process-based
modelling

Development of
management
recommendations
for farmers

Analysis and
interpretation

Monitoring of
results



Identifying pastures and grazing

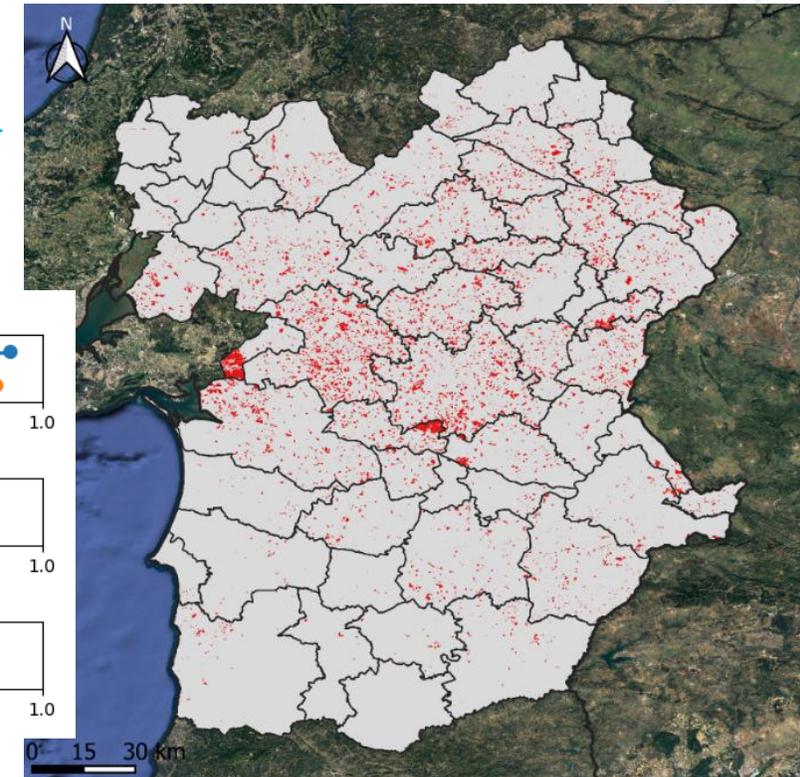
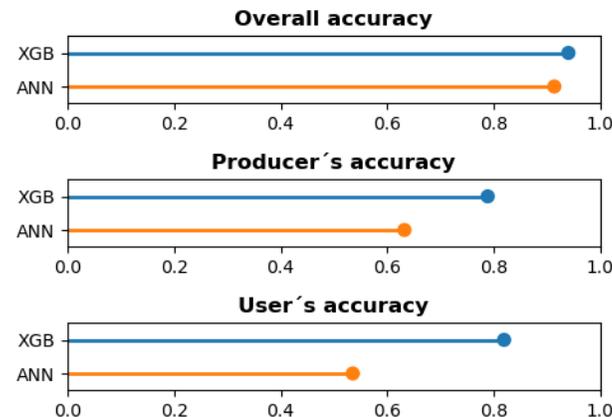
Satellite data



Project “GrassData”
(DSAIPA/DS/0074/2019)



Pasture Identification



Identifying pastures and grazing

Drone data

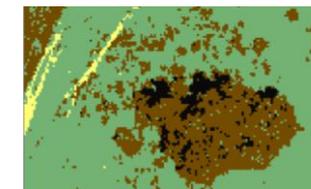


Object-based
classification

Pasture Identification



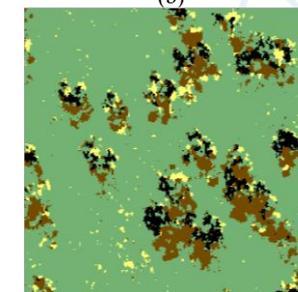
(a)



(b)



(c)



(d)

Legend

- Shadow
- Trees and Shrubs
- Bare Soil
- Sown Biodiverse Pastures

Project “GrassData”
(DSAIPA/DS/0074/2019)



IFAP
Instituto de Financiamento
da Agricultura e Pescas, I.P.

Identifying pastures and grazing

Tracking animal movement and intake

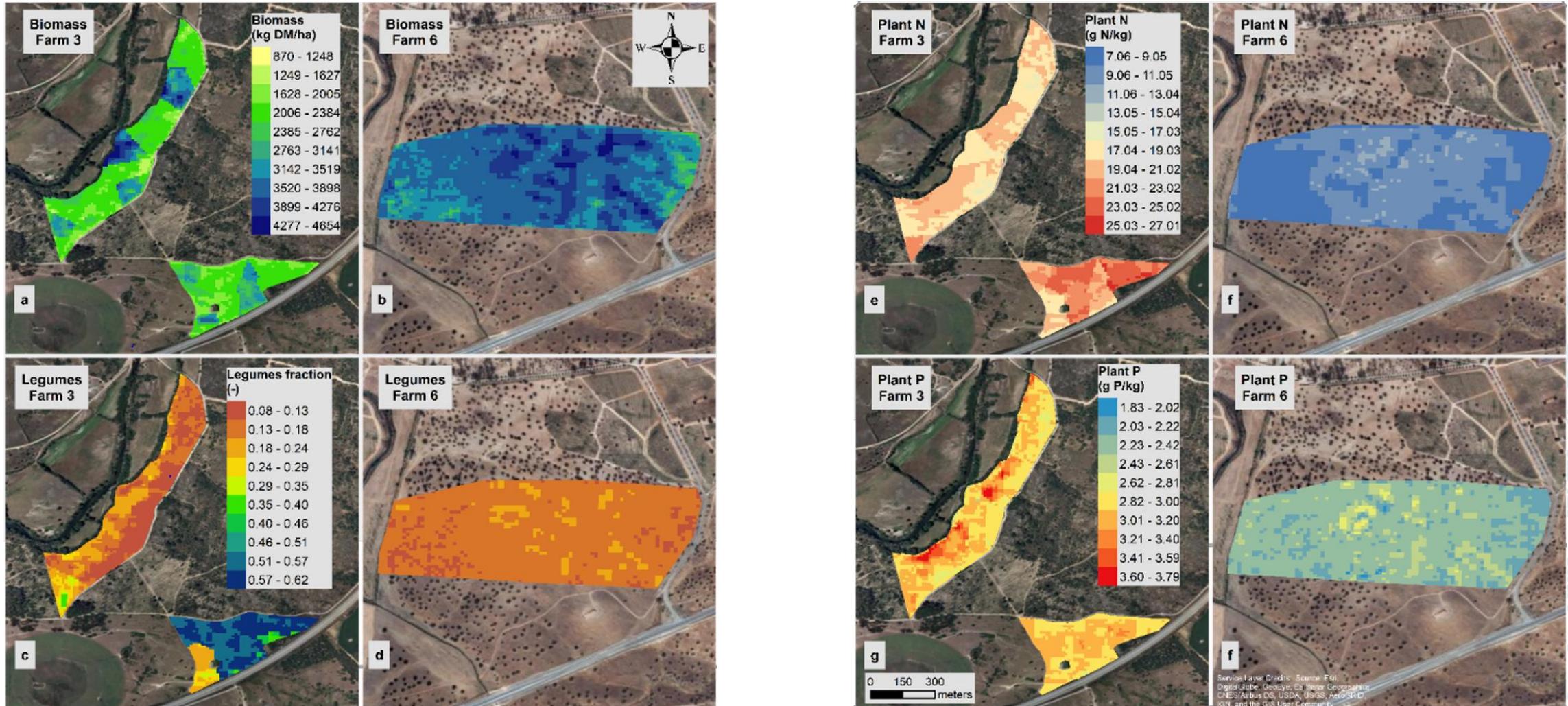
Sensors in collars (GPS, temperature, accelerometer)

- Amount and quality of pasture ingested (in combination with **satellite and drone images**)
- Nutrient inputs to soil (with **chemical analysis of faeces and urine**)

Projects “GreenBeef”
and “Sheep 4.0”



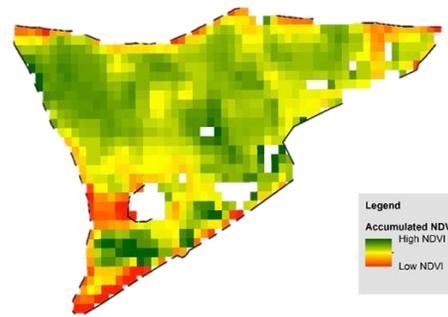
Estimating pasture yield and quality using satellites



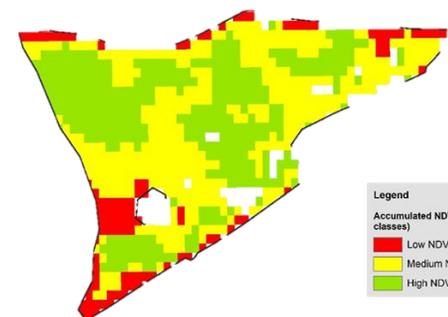
Acting on the system – precision fertilization



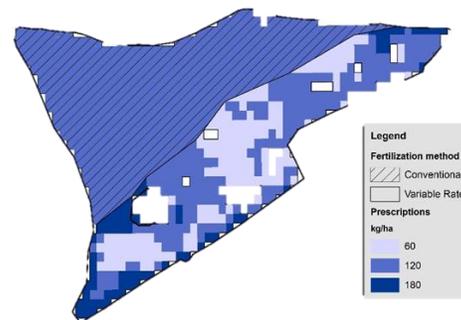
Accumulated NDVI



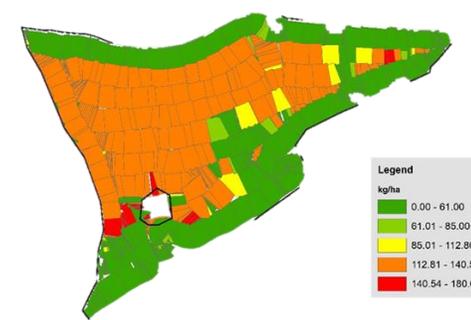
Accumulated NDVI in 3 classes



Fertilizer prescription



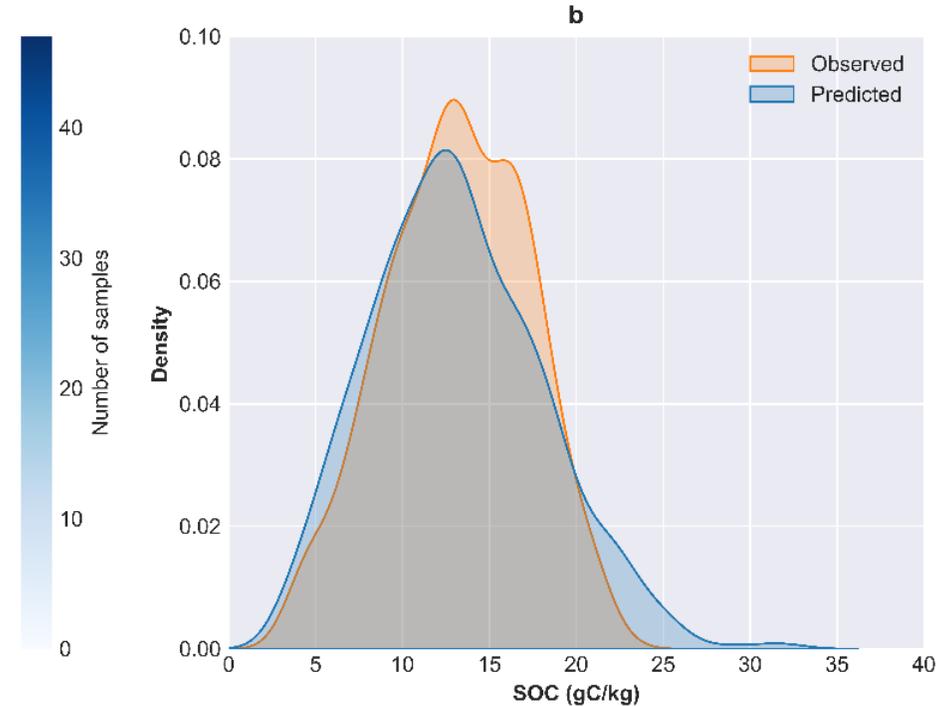
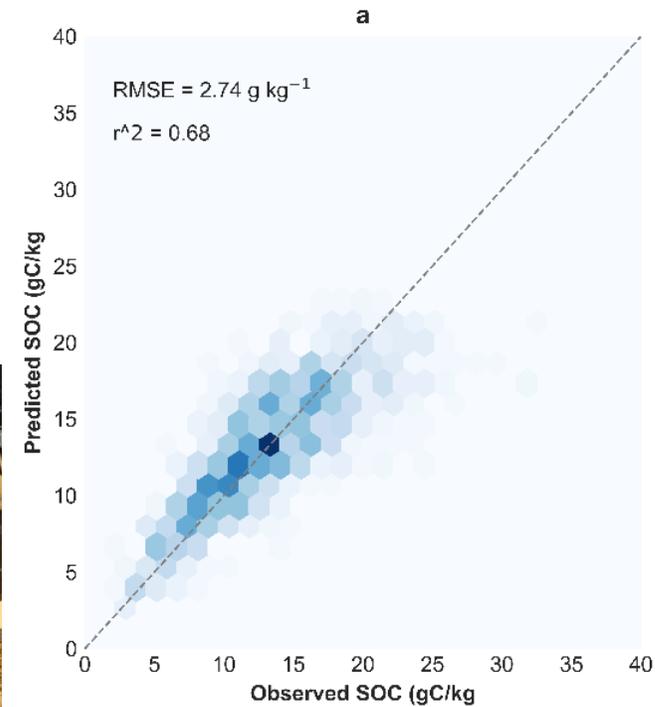
Fertilizer applied



Operational group
"GO Fósforo"



Estimating soil organic carbon using satellites



Operational group
"GO Solo"

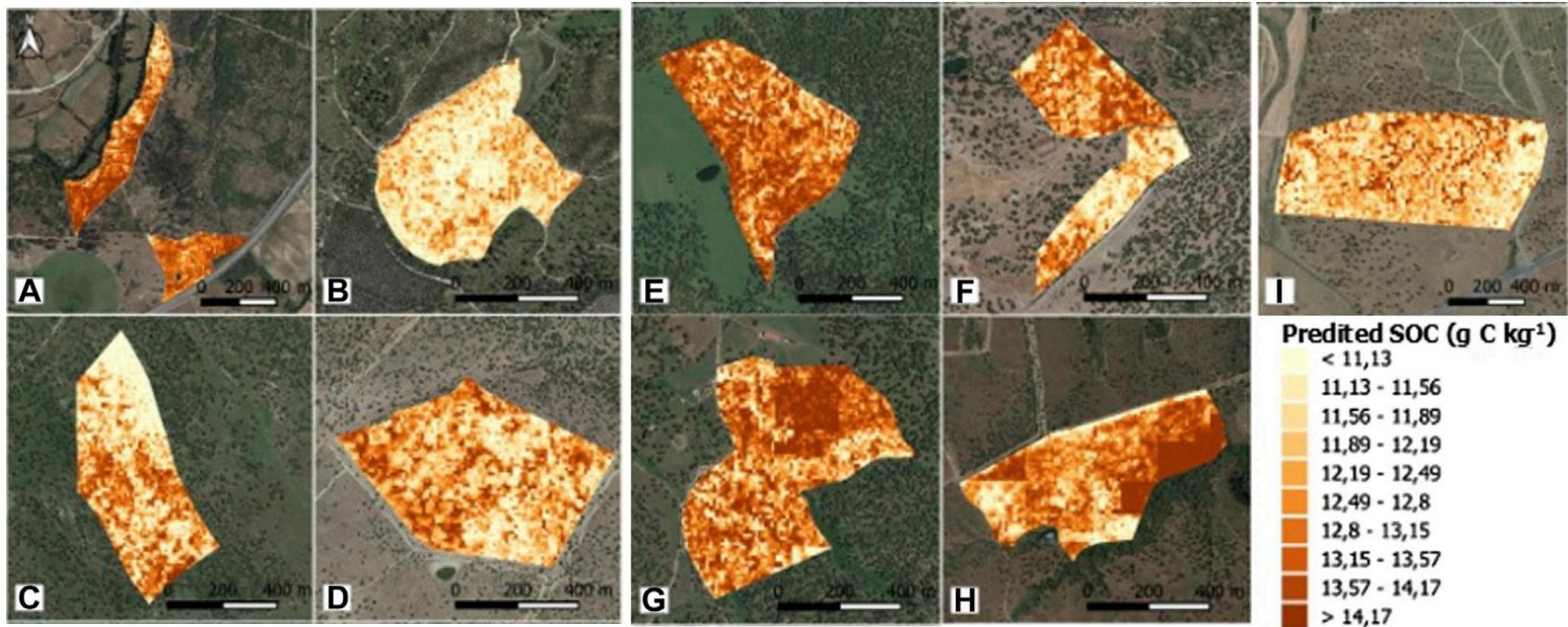


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DE ÉVORA



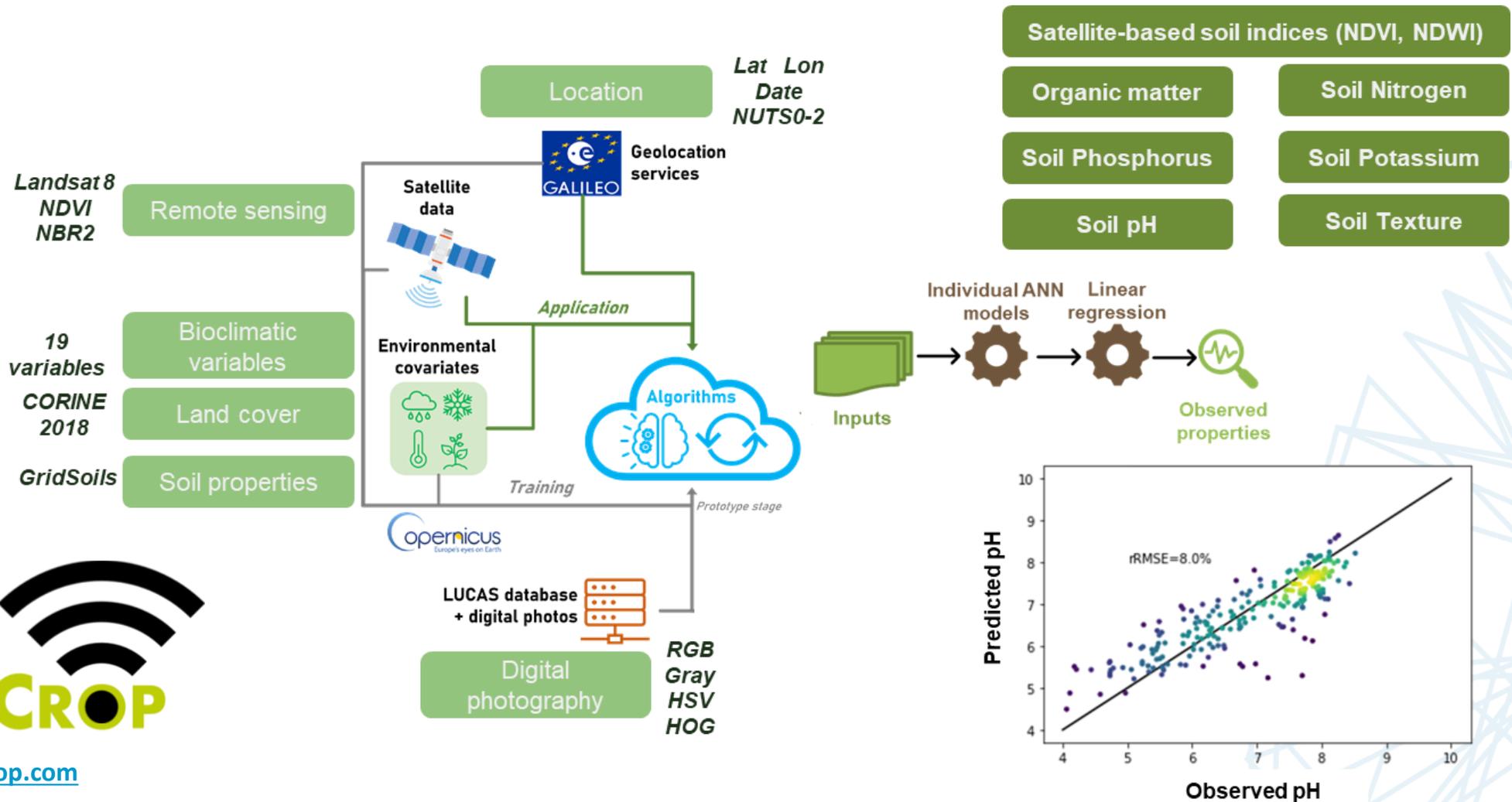
Instituto Nacional de
Investigação Agrária e
Veterinária, I.P.

Estimating soil organic carbon using satellites

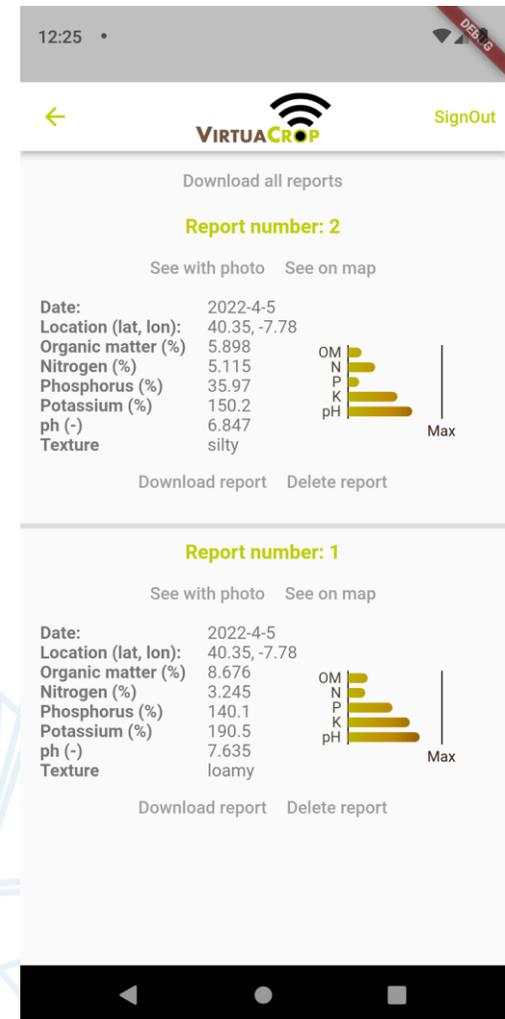
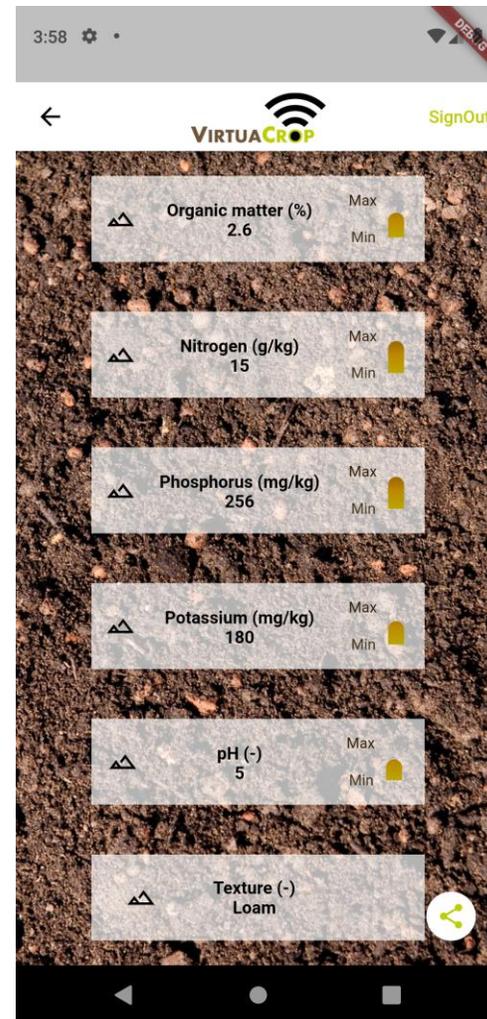
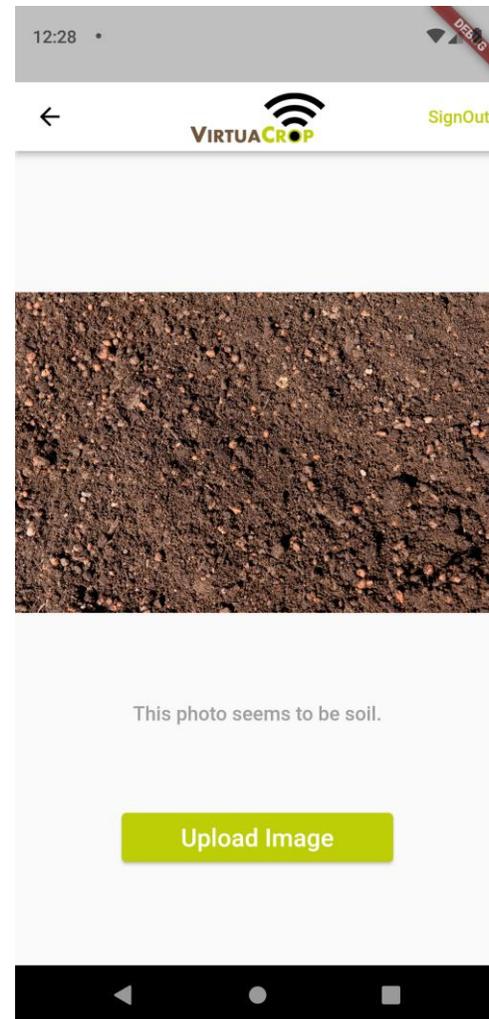
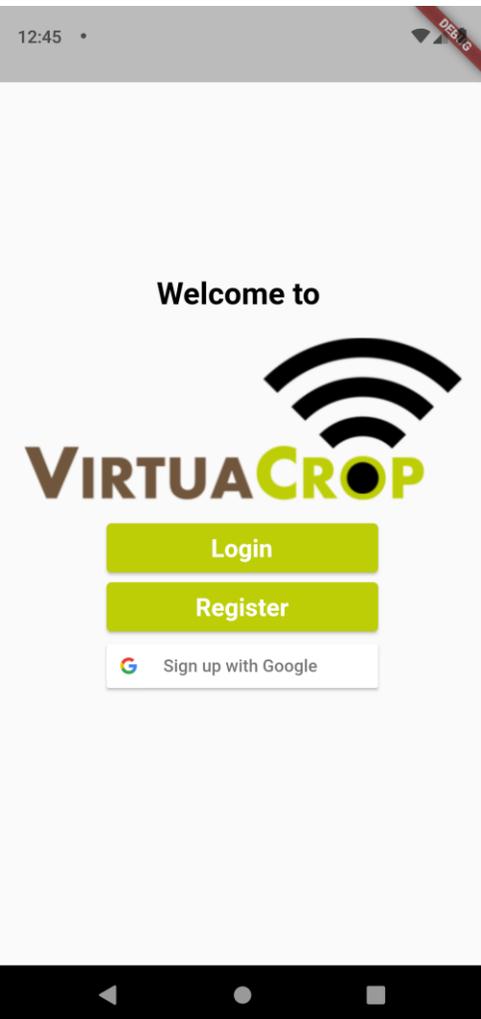


Operational group
"GO Solo"

Estimating soil organic carbon with digital photography



Estimating soil organic carbon with digital photography



Take home messages

-  “Regenerative farming” can use sustainable intensification and engineered systems
-  Sown biodiverse pastures are an example of regenerative engineered systems
-  Technology can help manage complex soil systems
-  **Technology and engineering can be allies of regenerative farming, not necessarily foes**

Thank you!

ricardo.teixeira@tecnico.ulisboa.pt

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