

# Dewatering efficiency in a novel pilot-scale of worm sludge treatment reed bed: temperate climate, Portugal



**Amir Gholipour**

amirgholipour@isa.ulisboa.pt

Supervisors: Rita Fragoso<sup>1</sup>, Ana Galvao<sup>2</sup>, Elizabeth Duarte<sup>1</sup>

1. LEAF-Linking Landscape, Environment, Agriculture and Food, Research Unit, Instituto Superior de Agronomia (ISA), University of Lisbon  
2. CERIS, Instituto Superior Técnico (IST), University of Lisbon

MIT Portugal 2023 Annual Conference

## 1. Introduction

Sewage sludge management is a global challenge and is commonly dewatered through conventional techniques like centrifugation process. Alternative sludge management like sludge treatment reed bed (STRB) can address the drawbacks in sludge dewatering with low-tech and low-energy. However, an efficient STRB relies on water balance status to stabilize sludge.

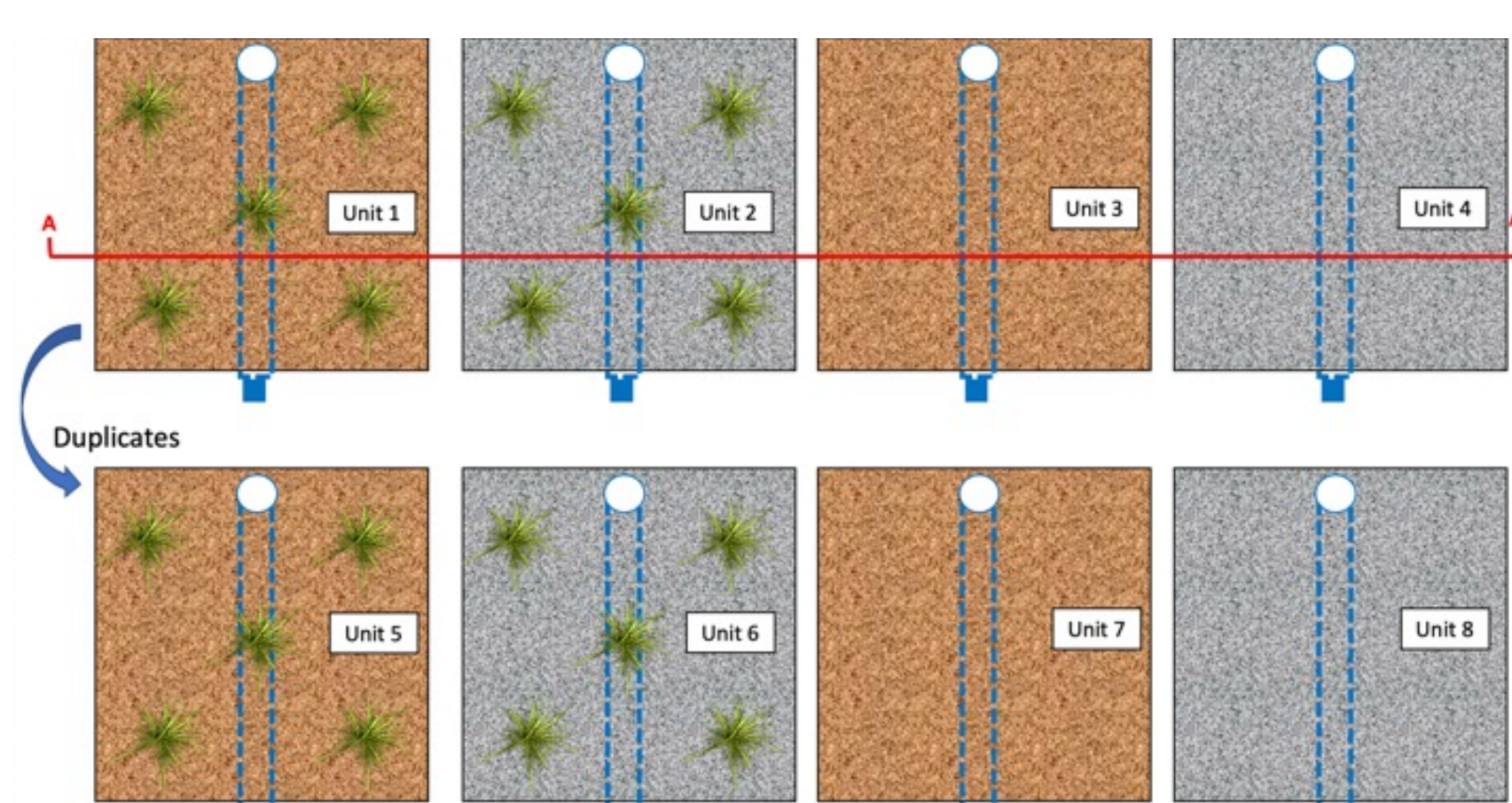
## 2. Aim

In this study in Portugal, the performance of STRB assisted with worms (W-STRB) planted with *Arundo donax* was assessed in the Mediterranean region at Beirolas WWTP, while monitoring water balance.



## 3. Material and methods

The experiment includes eight units of one cubic meter (Width: Length: Depth=0.95: 1.16: 1m). Units 1 to 4 are worm-planted (WP), planted (P), worm-control (W), and control (C) units (units 5 to 8 are the replicates of units 1 to 4). The study was in Beirolas WWTP, and the beds were fed with a mixed sludge (MS) from primary and secondary stages.

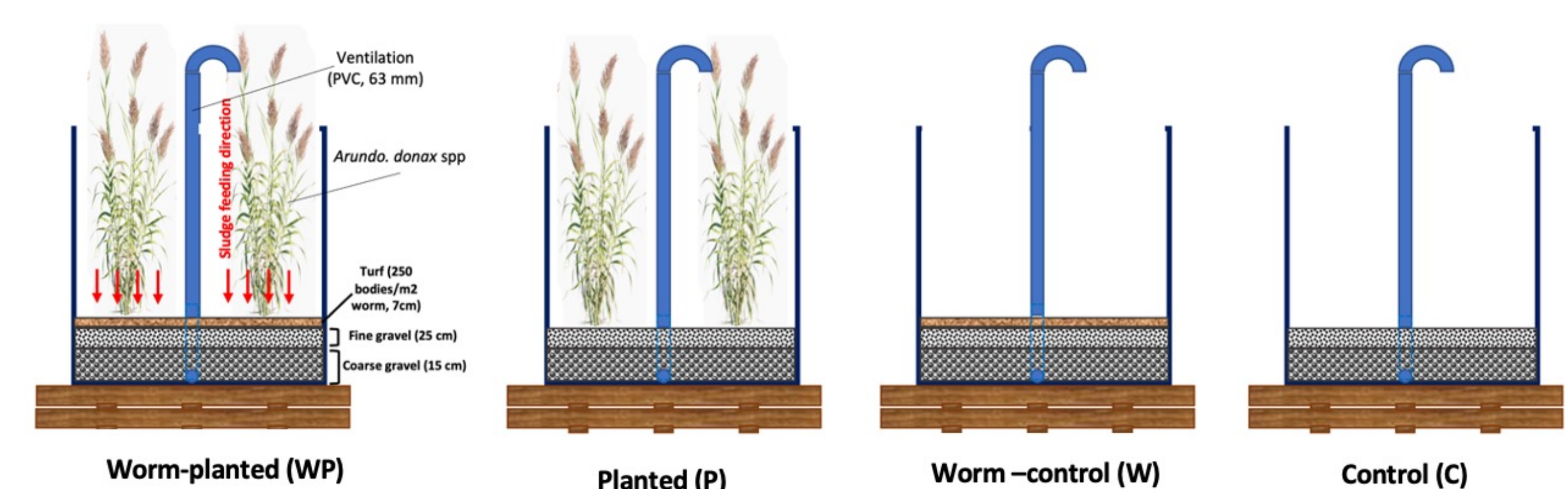
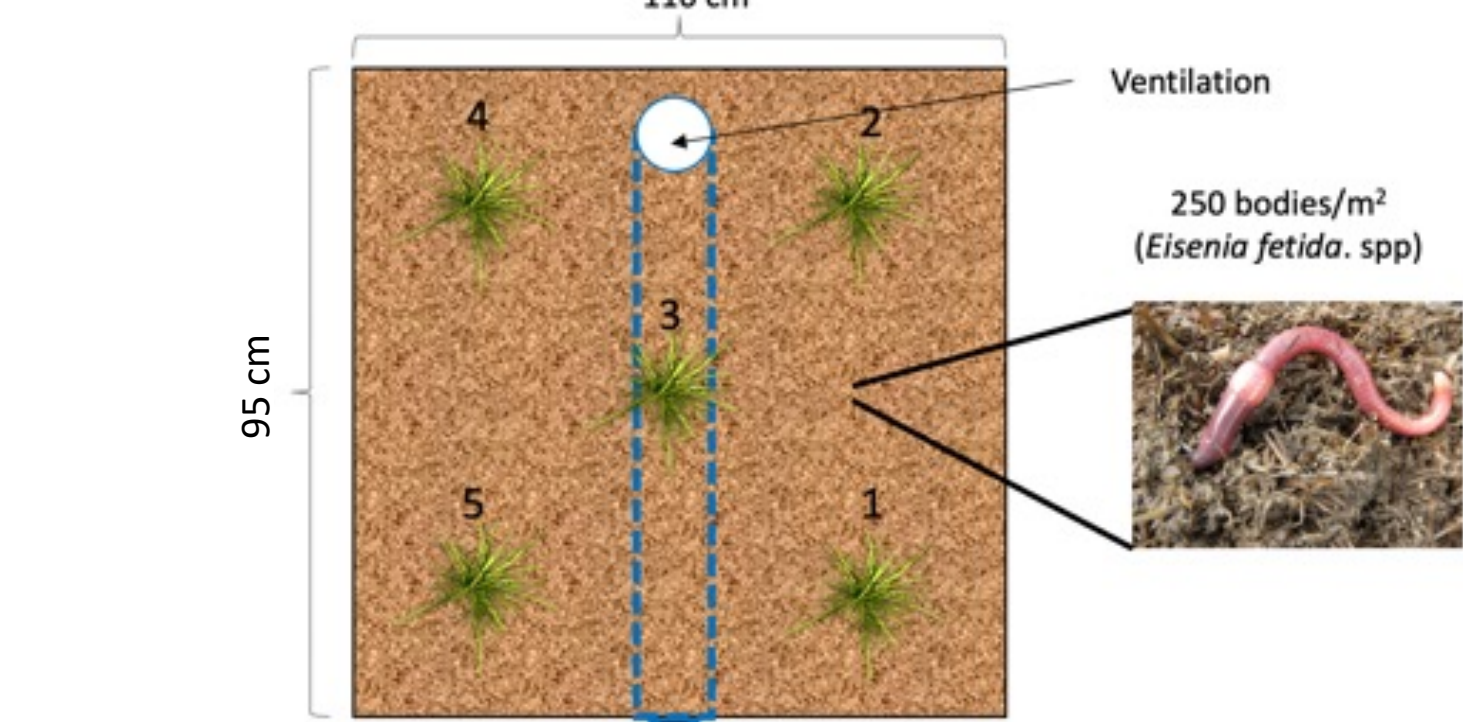


### Operational condition

- Feeding: two per month
- Resting: two weeks
- Sludge loading rate = 43.59 kg.dry solids (DS).m<sup>-2</sup>.year<sup>-1</sup>
- DS content: 25 g.VS.L<sup>-1</sup>
- Volatile solid (VS) content: 19 g.VS.L<sup>-1</sup>
- Dry season: May 9<sup>th</sup> to Aug 29<sup>th</sup>, 2022
- Wet season: Aug 29<sup>th</sup>, 2022, to May 11<sup>th</sup>, 2023

### Climate condition

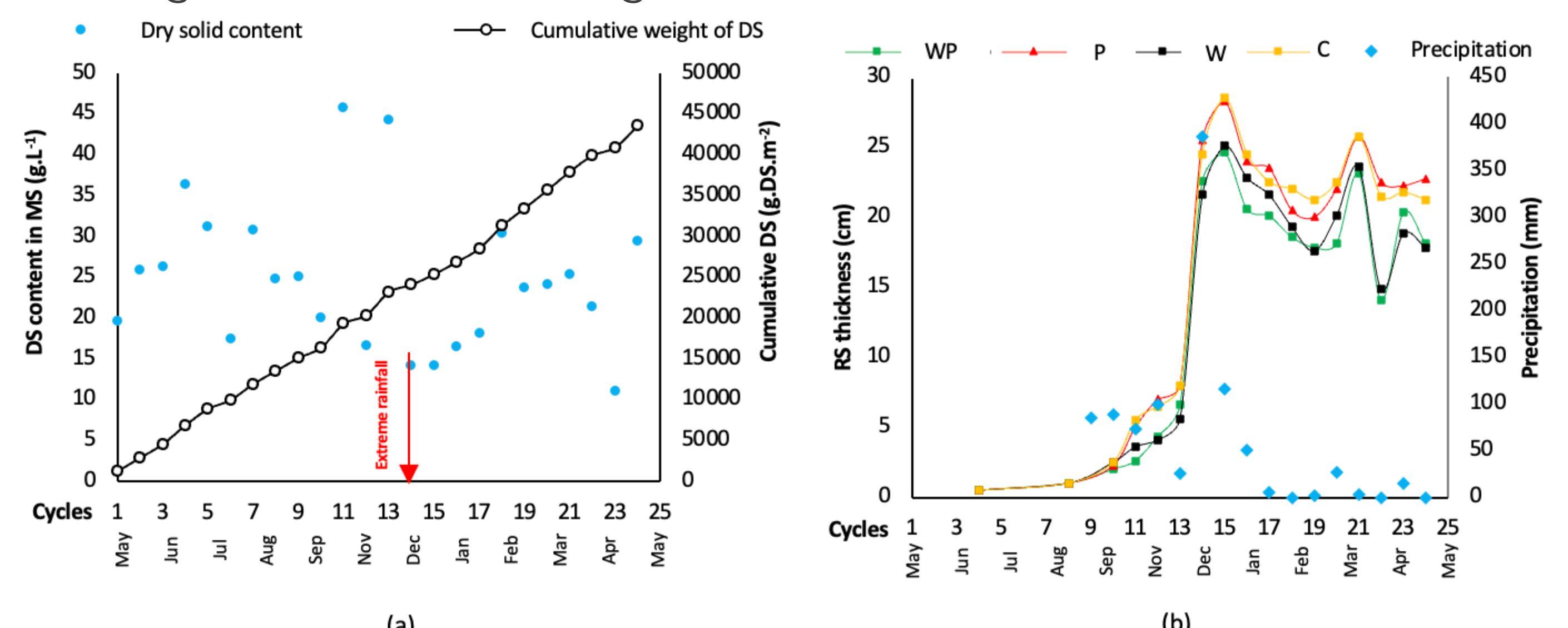
- Temperate climate: Portugal
- 906 mm .year<sup>-1</sup>
- 130 mm.day<sup>-1</sup>(max)
- Humidity = 99 and 14 %
- Ψ 763 mmHg
- 41.2 and 3 C°
- Max solar power = 1283 W.m<sup>-2</sup>
- Evapotranspiration: WP unit: 1633 L.year<sup>-1</sup>
- P unit: 1115 L.year<sup>-1</sup>
- Evaporation: W unit: 910 L.year<sup>-1</sup>
- C unit: 640 L.year<sup>-1</sup>



## 4. Results

In total, 43588 g.DS.m<sup>-2</sup>.year<sup>-1</sup> was fed to each unit through 24 cycles:

- ✓ The lowest DS of MS: (11.11 g.DS.L<sup>-1</sup> in the wet season)
- ✓ The highest DS of MS: 45.75 g.DS.L<sup>-1</sup>



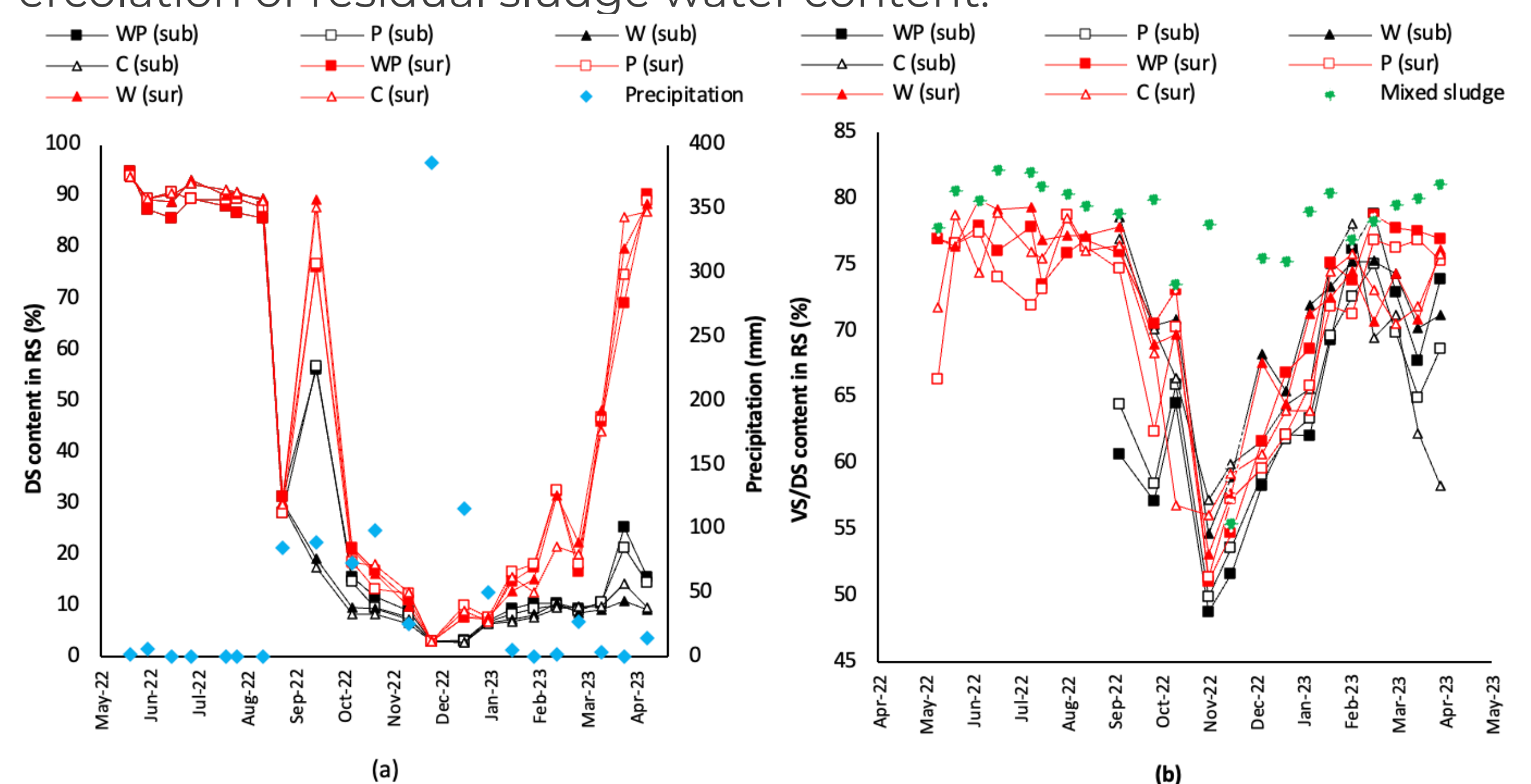
RS formation: a) DS content and cumulative DS, b) RS thickness and precipitation..

The thickness of residual sludge layer for all units:

- ✓ In the dry season → 1 cm (DS > 90% in all units)
- ✓ In the wet season → 30 cm (at the extreme rainfall event, DS < 5%)
- ✓ WP unit: 22 % less thickness compared to other units

Main factors that influenced the thickness variations:

- ✓ Rain
- ✓ Surface evaporation
- ✓ Percolation of residual sludge water content.



Dewatering efficiency and sludge stabilization: a) DS content for surface (sur) and subsurface (sub) layers, and b) VS/DS content for sur and sub-layers.

Overall, for all units:

- ✓ DS of the subsurface layer < DS of the surface layer (depending on rain)
- ✓ VS of the subsurface layer < VS of the surface layer (5 % less than the surface)
- ✓ 3 < DS < 95 %
- ✓ 49 < VS < 80 %
- ✓ WP unit showed 30 % higher DS at the end of study compared to other units

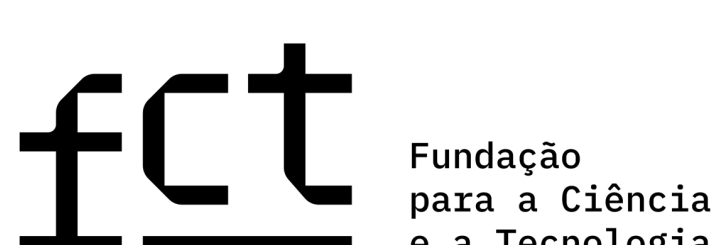
## 5. Conclusions

The result of the study indicated that incorporating worms into STRB (W-STRB) systems could be a viable method to improve dewatering efficiency in temperate climate. This study showed it could lead to a significant increase in DS content in the residual sludge. Worms contributed to the reduction of VS and the thickness of the residual sludge depended on precipitation and was lower during the dry season. Overall, W-STRB can be considered as an alternative for the conventional techniques.

## 6. Acknowledgement

We would like to appreciate LEAF-Linking Landscape, Environment, Agriculture and Food, Research Unit and LA/P/0092/2020 of Associate Laboratory TERRA and Aguas de Portugal for their continuous supports to develop the project.

Funded by:



under the Doctoral Grant SFRH/BD/151361/2021 | MPP research area