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# Mediterranean Integrated System for Water Supply «MEDISS»

project Duration:  
August 1, 2019 - July 31, 2022

Technical meeting and study visit  
8 - 10 November 2021  
Aqaba - Jordan

**WP ACTIVITIES**



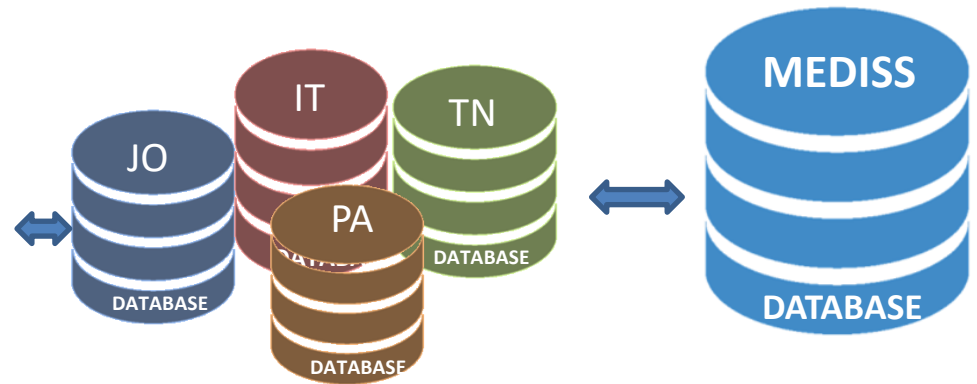
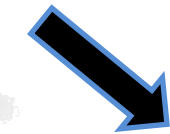


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## WP3 TECHNICAL ACTIVITIES

- ✓ *Data Collection (baseline)*
- ✓ *Data base - data set and cartography for pilot area - (being implemented)*
- ✓ *Monitoring (being implemented)*
- ✓ *Equipments and consumables*





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## WP4 PILOT PLANT

- ✔ **Pilot plant management**
- ✔ **Monitoring on pilot plant process (experimentation)**
- ✔ **Equipments and consumables for plant (being implementation)**
- ✔ **Testing at the agricultural site - December in Italy**





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## WP5 COMMUNICATIONS AND BEST PRACTICES



Università degli Studi di Cagliari  
Dipartimento di Lettere, Lingue e Beni Culturali  
Dottorato in Storia, Beni Culturali e Studi Internazionali

**Raccontare il territorio  
Narrazioni geografiche a confronto**  
Notte Internazionale della geografia 2021

9 aprile 2021 dalle ore 16:00

*Organizzano l'evento*  
Luciana Mocco, Rachele Piras, Giovanni Sistu, Marcello Tanca

*Con la partecipazione di*  
Raffaele Cattedra, Maria Antonietta Dessena, Mother Hind, Roberto Ibbà, Mann Invisible, Tomaso Ledda, Maria Luciana Mocco, Gian Giacomo Ortu, Carlo Perelli, Laura Pinna, Giovanni Sistu, Angelo Turco, Ennio Vacca, Anna Maria Vigna

Link zoom per partecipare:  
<https://us07web.zoom.us/j/84857987513>  
ID riunione: 848 0407 5133  
Passcode: 440FU

WWW.GEO5IGHT.5EU



Interreg  
Mediterranean  
RE-LIVE WASTE  
Project co-financed by the European Regional Development Fund

*Tavola Rotonda del progetto RE-LIVE WASTE*  
*Martedì 15 Dicembre 2020*

*Scenari futuri di sostenibilità ed economia circolare nelle produzioni zootecniche*

Agenda	
10:00 – 10:15	Saluti di benvenuto e introduzione (D. Mulas – LAORE) (M. Gutierrez – UNISS)
10:15 – 10:30	Il progetto Re Live Waste, obiettivi e <u>strategie</u> (A. Cincotti – UNISS) (D. Usai – LAORE)
10:30 – 10:40	La Direttiva Nitrate e l'esperienza di Arborea nella gestione degli effluenti zootecnici. (A. Manca – LAORE)
10:40 – 10:50	L'impianto pilota "Produzione Struvite"; aspetti tecnici ed economici (G. Ragaglia – UNISS)
10:50 – 11:00	Piani e programmi per le politiche di Sostenibilità e di Economia circolare nel settore Zootecnico (M. Gutierrez – UNISS)
11:00 – 12:00	Tavolo rotonda
12:00 – 12:10	Informare e comunicare la Sostenibilità e l'Economia circolare nel settore zootecnico (T. Solinas – UNISS)

Per partecipare all'evento:  
<https://us02web.zoom.us/j/84857987513> Argomento: Tavola Rotonda RE-LIVE WASTE Ora: 15 dic 2020 10:00 AM Amsterdam, Berlino, Roma, Stoccolma, Vienna Entra nella riunione in Zoom  
<https://us02web.zoom.us/j/82141101343>



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**WP3 ACTIVITIES**



# Data Collection and GIS Applications



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Main advantages of using QGIS software such as :

- It's a open source (free download - <https://www.qgis.org/it/site/forusers/download.html>);
- You can view the study areas and insert the monitoring points;
- You can load select and save the monitoring data in the database and then analyzed them;
- You make spatial analysis and relate them to the different environmental situations;
- You can create thematic maps.



## QGIS-Mediss Project



# Data Collection on QGIS

The image displays a collage of screenshots from QGIS and other software, illustrating data collection workflows. The main QGIS window shows a map of a site with various layers and a data table for 'Wells-Piezometers UTM32N'. The table includes columns for 'Date', 'Lab Company', 'Superior responsible of lab', 'Sampling Date', 'Temperature [°C]', 'pH [pH]', and 'Conductivity [µS/cm]'. The data rows show measurements taken on 2021-01-26, 2021-01-28, 2021-02-16, and 2021-02-16.

Other screenshots show field work photos, a laboratory data table for 'PVEB LAB', and a soil analysis table for 'Analyse des sols'. The soil analysis table includes columns for 'Soil Type', 'Angle (%)', 'Limon (%)', 'Sable (%)', 'Class Texture', 'Calcaire total (%)', 'Calcaire actif (%)', and 'Potentiel d'hydrogène (pH)'. The data rows show soil types AH (0-20), AH (20-40), AH (40-60), HH (0-20), HH (20-40), HH (40-60), and MH (0-20).

The laboratory data table for 'PVEB LAB' shows existing water parameters range for various ions and temperature. The data rows show parameters like E.C. [µS/cm], T [°C], NO3 [mg/L], Cl [µg/L], CaCO3 [mg/L], Mn [µg/L], HCO3 [mg/L], pH, Na [mg/L], NO3 [mg/L], SO4 [mg/L], CO3 [mg/L], and HCO3 [mg/L].

The soil analysis table for 'Analyse des sols' shows existing water parameters range for various parameters. The data rows show parameters like E.C. [µS/cm], pH, T [°C], HCO3 [mg/L], NO3 [mg/L], SO4 [mg/L], Na [mg/L], and CaCO3 [mg/L].



# Arborea pilots area



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Pilot areas for testing fertilizer



Arborea

Tanca Ma

# Results



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The first results (January 2021 - September 2021), show small variability in **waters parameter in each site “white simple”**. In general **rule piezometer n. 2** were characterized by higher levels of :

- **Electric conductivity;**
- **Chlorides;**
- **Hardness, Ca, Mg, Na and K;**
- **Nitrates;**
- **Total Organic Carbon (TOC).**

**The stability in water parameters in each site helps us to detect possible changes that could occur during the experiment activity**

# Chemical and Biological water first results

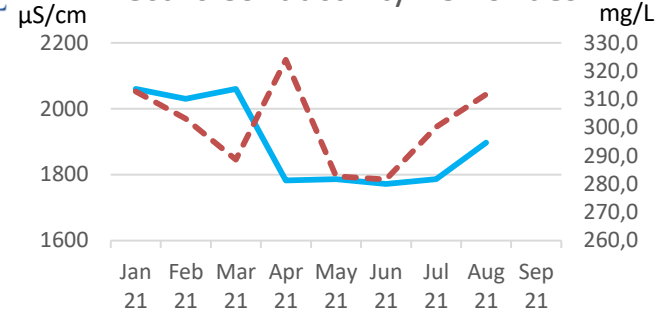


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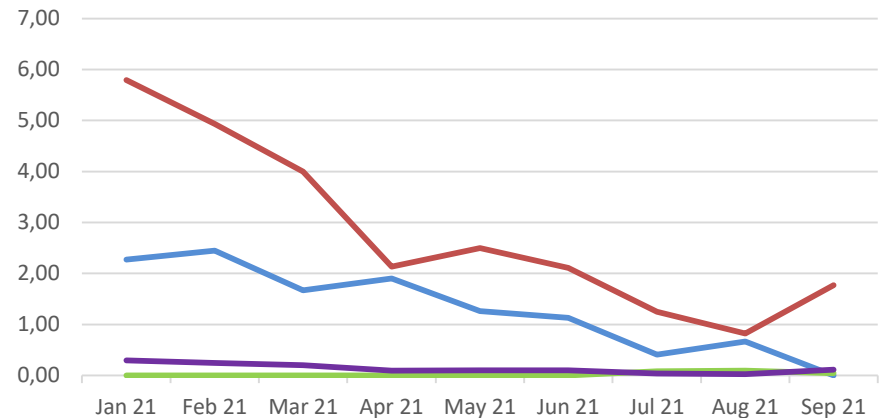
Piez. n. 2

Electric Conductivity - Chlorides



E.C. a 25 °C microS/cm Chlorides mg/L

Piez. n. 2  
Nitrogen Compounds



Nitrates mg/L N-NO3 Tot. Nitrogens mg/L N  
Ammoniacal Nitrogen mg/L N-NH3 Nitrites mg/L N-NO2-

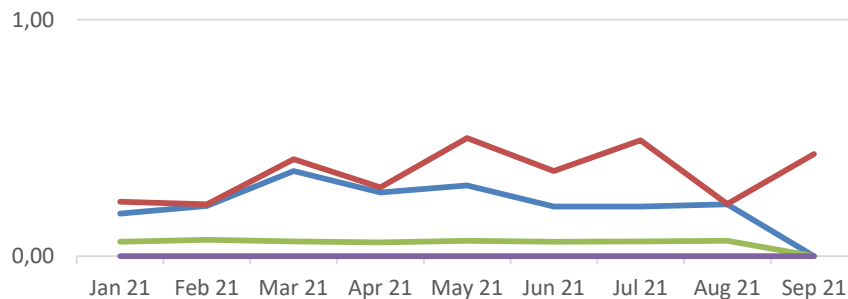
Piez. n. 1

Electric Conductivity- Chlorides



E.C. 25 °C µS/cm Chlorides mg/L

Piez. n. 1  
Nitrogen Compounds



Nitrates mg/L N-NO3  
Tot. Nitrogens mg/L N  
Ammoniacal Nitrogen mg/L N-NH3  
Nitrites mg/L N-NO2-



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**WP4 ACTIVITIES**

**AMMONIA RECOVERY PILOT UNIT - PRELIMINARY RESULTS**

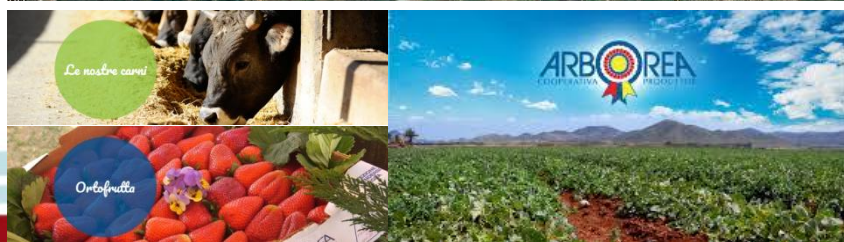
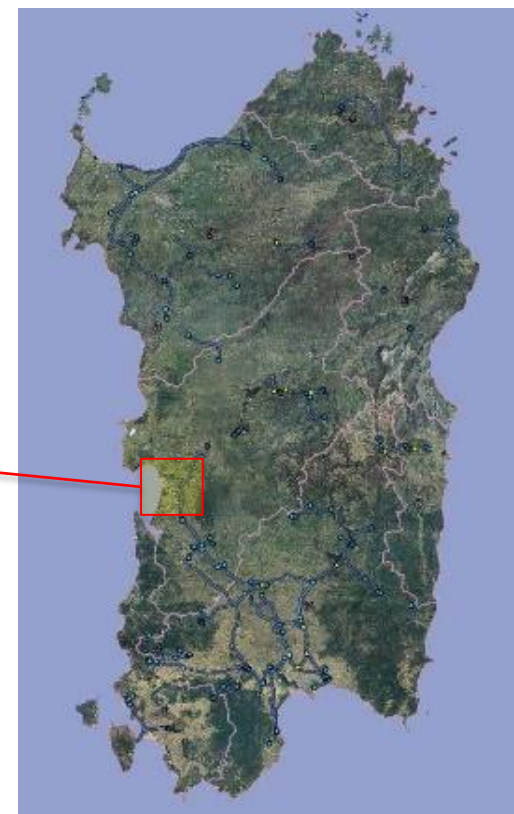
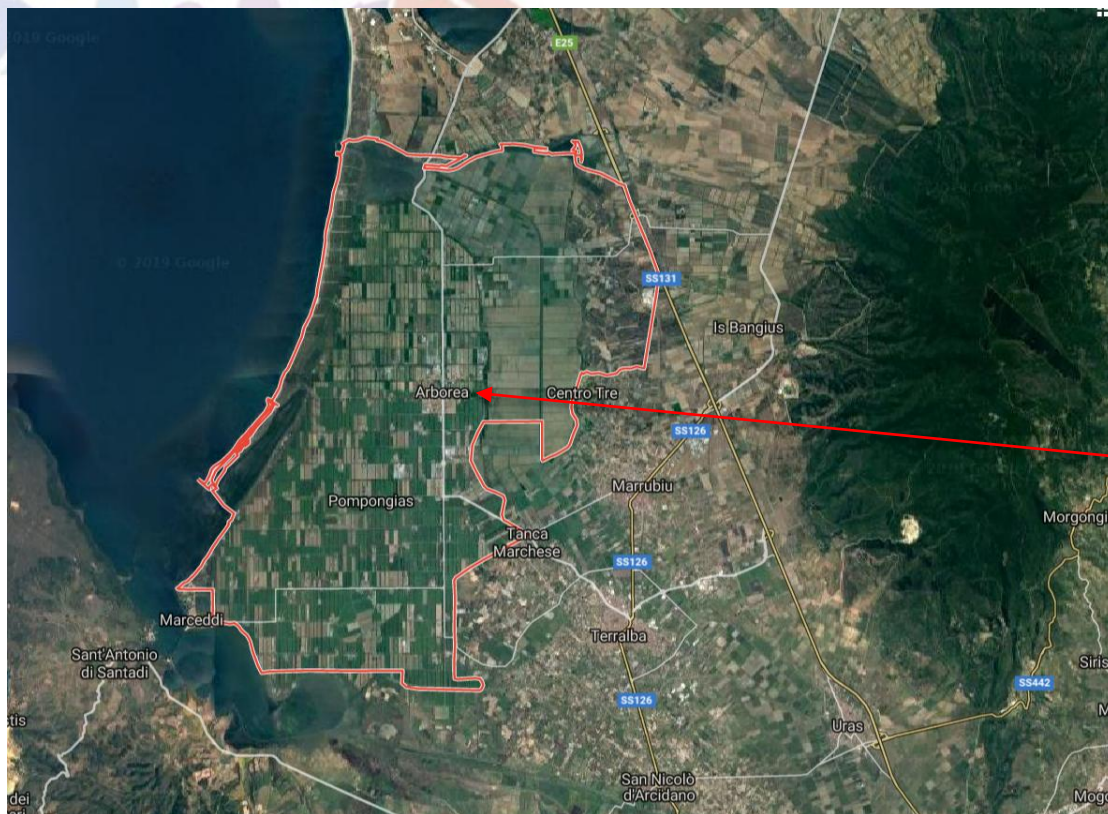




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## The test pilot area in Sardinia: **the Arborea plain**

Arborea is a municipality in the province of Oristano and gives the name to a very extended area (6'000 ha) devoted to intensive cattle farming (for dairy and meat production) and agricultural activities: It represents an excellence in the Sardinian agro-livestock system



Farmers are associated into the **"Cooperative producers of Arborea"** that is today one of the most important hub of the Sardinian agricultural and livestock industry and gathers more that 200 members



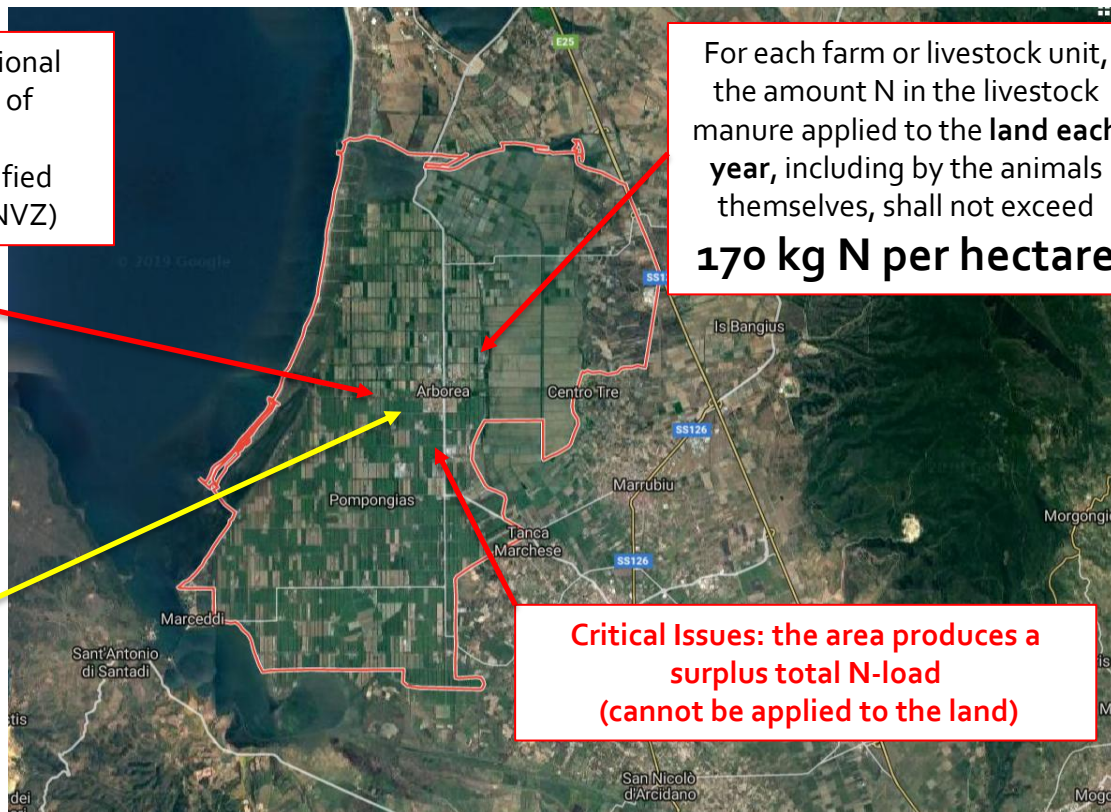
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# The test pilot area in Sardinia: **the context**

Due to the intensive agricultural practices, the Regional Council of the Sardinia Region (resolution n. 1/12 of 01/18/2005, according to the **EU directive 91/676/EEG**) classified the plain of Arborea a **Nitrate Vulnerable Zone (NVZ)**

For each farm or livestock unit, the amount N in the livestock manure applied to the **land each year**, including by the animals themselves, shall not exceed **170 kg N per hectare**

## AMS Experimental Pilot Unit



**Critical Issues: the area produces a surplus total N-load (cannot be applied to the land)**

### **AIM OF THE PROJECT:**

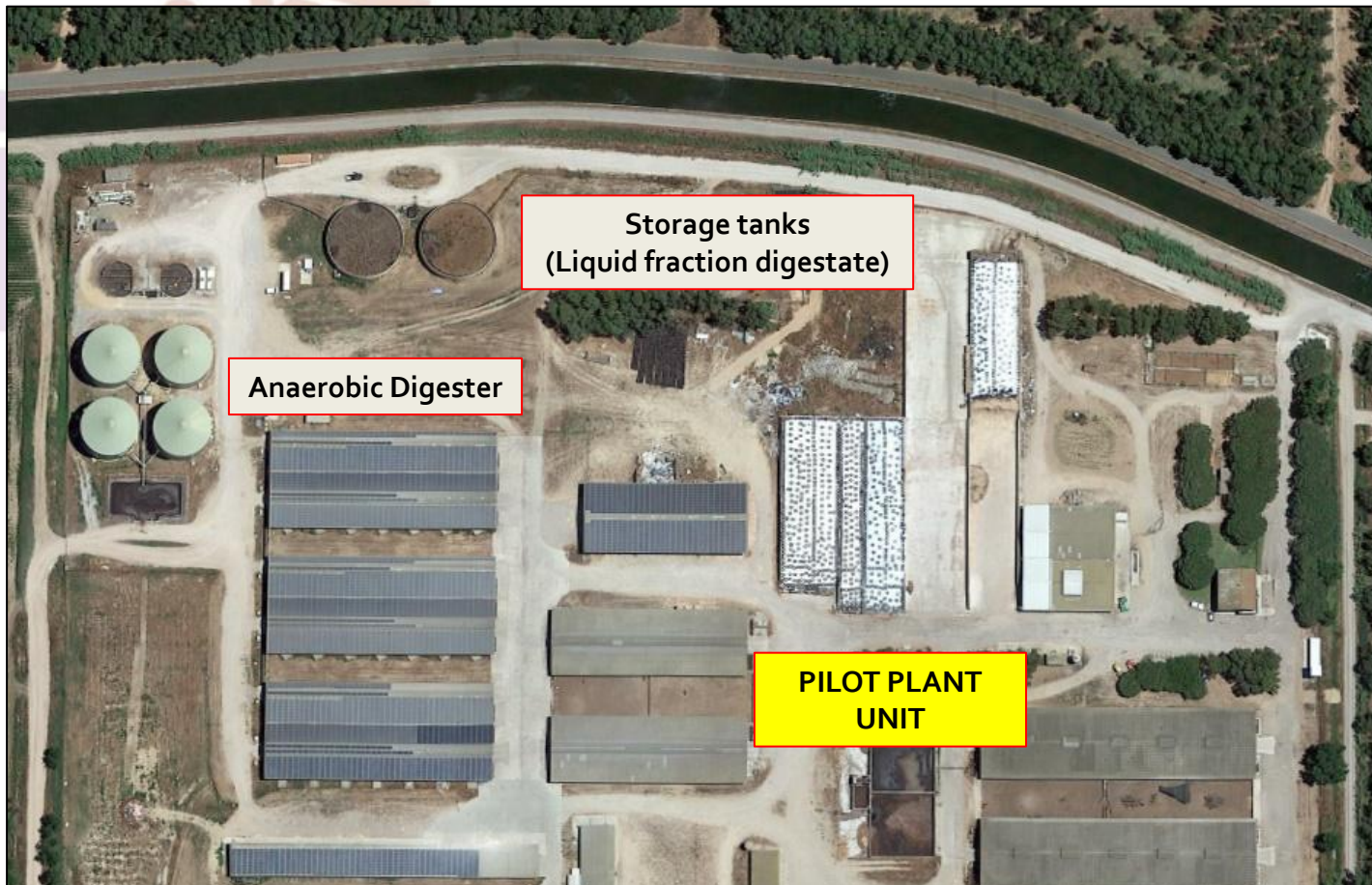
*To evaluate the sustainability of a technology to reduce N-load in the manure produced in Arborea plain and to recover the ammonia fraction as a fertilizer (ammonium Sulphate) that can be stocked and reused in controlled way*



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# Ammonia Recovery from anaerobic digestate by means of gas permeable membranes

Fattening calves centre



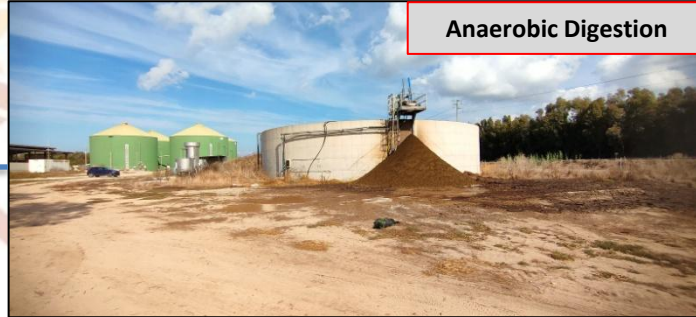
Livestock manures are treated by an anaerobic digester coupled by a high efficiency power cogenerator fed by the produced biogas  
The high concentration of Nitrogen, above 2000 mg/L is suitable for the experimentation

# Ammonia Recovery Scheme



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Anaerobic digestate  
**1800 mg/L NH<sub>4</sub>**



Anaerobic Digestion

Liquid fraction  
Anaerobic digestate  
**1800 mg/L NH<sub>4</sub>**

PRE-TREATMENT  
VIBRATING SCREEN UNIT  
(mesh size 50µm)

AMMONIA  
MEMBRANE  
STRIPPING UNIT

Effluent disposal  
**100 mg/L NH<sub>4</sub>**  
Recovery efficiency 90 %

Final Product  
**(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>**  
**(2% as N)**

Solid fraction disposal







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# Ammonia Recovery from anaerobic digestate by means of gas permeable membranes

## March 2021 – pilot plant installation





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# Ammonia Recovery from WWTP digester by means of gas permeable membranes

## June 2021 – Press conference – inauguration and start-up of the pilot plant



**Agricoltura e zootecnia sorridono all'ambiente**  
 Arborea. Progetto sperimentale della cooperativa Produttori unico in Italia per riutilizzare i liquami

ARBOREA  
 Trasformare i liquami di stalla in fertilizzanti per l'agricoltura è esattamente una novità. L'impianto sperimentale per seccare attraverso speciali membrane l'ammoniacale dai reflui, inaugurato ieri mattina alla Cooperativa Produttori Arborea, è invece particolarmente innovativo. È il primo del suo genere a essere realizzato in Italia e nasce all'interno del progetto Medias, acronimo che sta per water supply, che anche in Palestina, Giordania e

Tunisi, con interventi diversi da quello adottato in Sardegna, sta sperimentando nuove soluzioni per un utilizzo più razionale dell'acqua nei terreni dove la nuova invece scarseggia. La scelta di Arborea per realizzare l'impianto sperimentale è stata casuale, essendo un'area sensibile per la presenza di nitrati nelle falde sotterranee e in alcuni comuni (Zona vulnerabile da nitrati di origine agricola). Questo della interazione di nitrati nei terreni più ricchi di nitrati, la cui economia è basata in gran parte sulla zootecnia comparto al quale in questo pezzo di Campidano nessuno vuol rinunciare. Ora per la tecnologia potrebbe dare una mano che ieri mattina, la nostra azienda, Manuela Frassinetti, ha chiamato "agro-zootecnia sostenibile", dirige una importante sul territorio. Durante la conferenza inaugurazione coordinata dalla prefettura del progetto Medias, Arborea ha presentato l'intero progetto del Comune di Arborea e Produttori di Arborea e il primo dell'intero sistema dell'agricoltura integrata con il sistema generato con il sistema generato di Enas, Maurizio Canalis, il presidente della Cooperativa produttori Arborea, Walter Mulas-

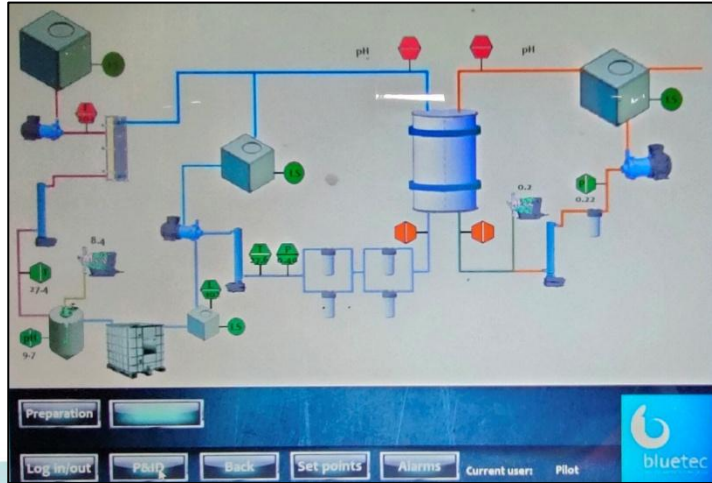




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# Ammonia Recovery from anaerobic digestate by means of gas permeable membranes

August 2021 – Beginning of the experimental activity





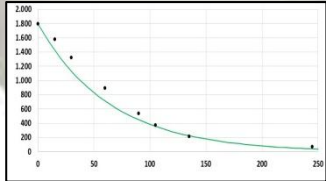
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# Ammonia Membrane Stripping Batch Process

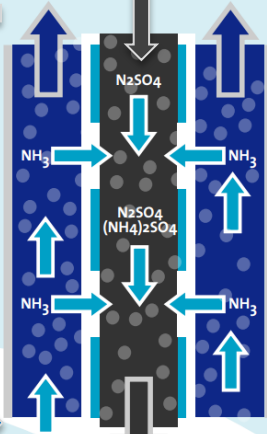
Digestate rich in  $\text{NH}_4$   
STORAGE TANK

250 L

The **caustic digestate stream** is lead to the feed side of a gas permeable membrane.  $\text{NH}_3(\text{g})$  passes through the membrane



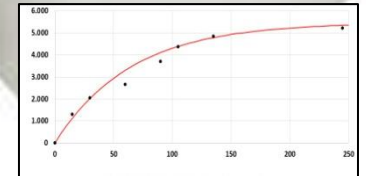
Wastewater or outside of fiber



At the product side of the membrane the **acidified stream** transforms the  $\text{NH}_3$  into ion-form  $\text{NH}_4^+$  which forms ammonium sulfate  $(\text{NH}_4)_2\text{SO}_4$

$(\text{NH}_4)_2\text{SO}_4$  Fertilizer  
STORAGE TANK

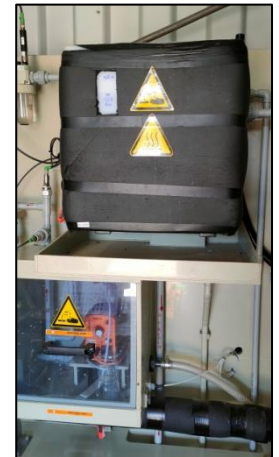
60 L



Ammonia gas is carried away from inside the hollow fiber



HYDROPHOBIC GAS PERMEABLE MEMBRANE





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# Ammonia Recovery from anaerobic digestate by means of gas permeable membranes

## Pilot Plant Experimental activity programm

### Optimization of the Ammonia Stripping Process

#### 1) Adjustment of the process parameters

- **pH** (feed line) and (acid line)
- **Temperature** (feed line) and (acid line)
- **Flow rate** (feed line) and (acid line)
- Number of **membrane modules** to be used

#### 2) Modeling of the change in Ammonia concentration

- *Determination of Ammonia mass transfer coefficient*

### Optimization of the Chemical Analysis Protocol

1. Sampling frequency
2. Testing reliability of field Ammonia spectrophotometer (GMSOLUTION srl)
3. Testing reliability of field Ammonia on-line sensor
4. Double sampling is also repeated to analyze the same parameters at the main chemical laboratory according to the standard methods analysis
5. Chemical characterization of the final product (ammonium sulphate)

AIM: producing ammonium sulphate  $(\text{NH}_4)_2\text{SO}_4$



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# Ammonia Recovery from WWTP digester by means of gas permeable membranes

## FIELD CHEMICAL ANALYSIS SETUP



**DIGESTATE SAMPLE**

time (min)	CAUSTIC SIDE				ACID SIDE			
	pH	cond (mS/cm)	T (°C)	CAUSTIC SIDE: Ammonia - mg NH <sub>4</sub> /L	pH	cond (mS/cm)	T (°C)	ACID SIDE: Ammonia - mg NH <sub>4</sub> /L
0	12,00	37,80	22,00	1.800	1,39	58,90	18,50	0
15	12,29	39,30	21,90	1.580	1,84	38,10	31,30	1.300
30	12,62	47,80	22,00	1.320	2,33	34,30	21,80	2.050
60	12,87	63,50	22,50	890	2,28	39,00	23,10	2.650
90	12,86	67,80	23,70	540	2,48	40,00	24,00	3.700
105	12,76	67,50	24,90	370	2,33	40,80	24,90	4.360
135	12,72	67,00	25,80	215	2,37	43,00	25,60	4.840
245	12,71	65,90	27,90	66	3,15	41,10	28,10	5.220



**Ammonium Sulphate fertilizer (up to 2% N) SAMPLE**



**SAMPLING**



**pH, T sensor**



**NH<sub>4</sub> vials**



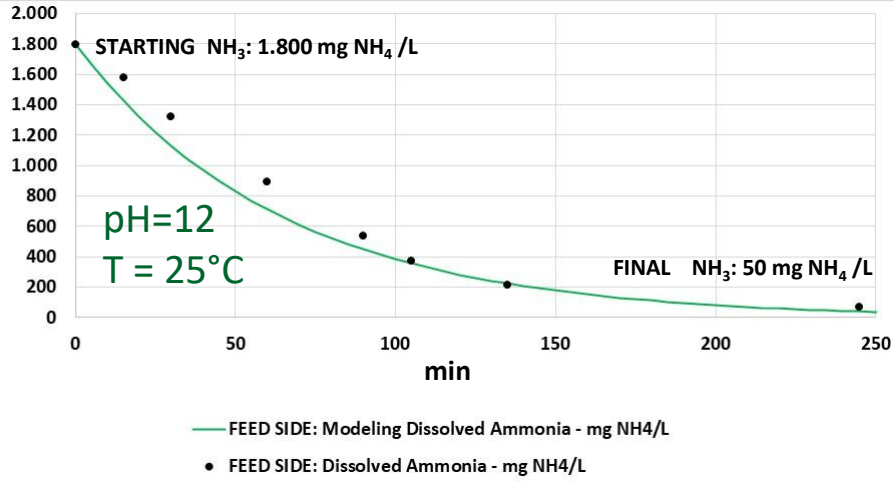
**NH<sub>4</sub> spectrophotometer**



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# Ammonia Recovery from anaerobic digestate by means of gas permeable membranes

## PRELIMINARY RESULTS

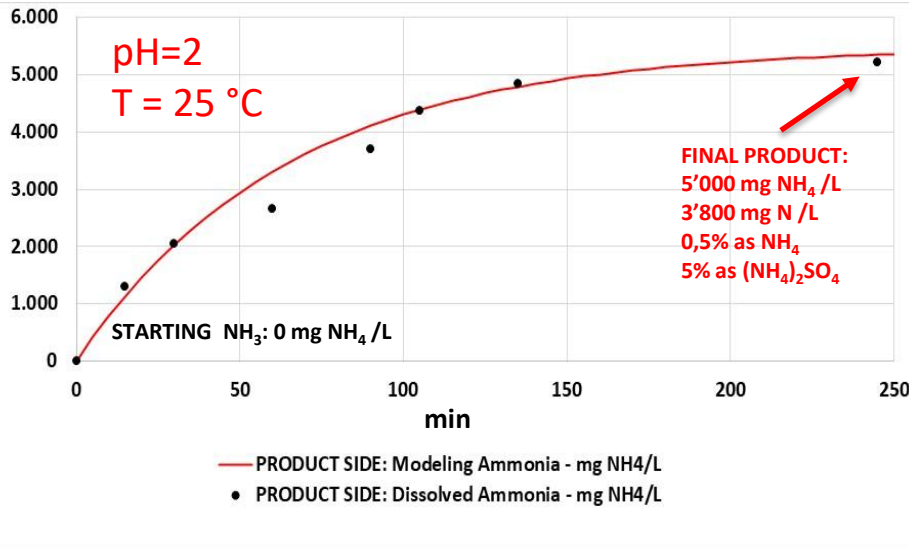


**DIGESTATE SAMPLE**

**FEED LOOP SIDE (1 run)**

STORAGE VOLUME: 260 L

**TOTAL  $\text{NH}_3$  LOAD PASSED : 455g  $\text{NH}_4$**



**Ammonium Sulphate fertilizer (up to 2% N) SAMPLE**

**PRODUCT LOOP SIDE (1 run)**

STORAGE VOLUME: 65 L

**FINAL TOTAL  $\text{NH}_3$  LOAD STORED : 455g  $\text{NH}_4$**



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# Ammonia Recovery from anaerobic digestate by means of gas permeable membranes

## REMARKS

- The Ammonia Membrane Stripping technology (AMS) is able to recover the ammonium from the digestate produced by the anaerobic sewage treatment unit located in the fattening calves center of Arborea
- The Ammonia removal/recovery efficiency of the pilot unit has reached up to **95%**
- The recovered Ammonia has been converted into a solution of ammonium sulphate  $(\text{NH}_4)_2\text{SO}_4$  and its concentration depends on the amount of Ammonia recovered in the pilot unit (number of cycles). After three cycles the concentration of the ammonium sulphate  $(\text{NH}_4)_2\text{SO}_4$  solution reached about **18'000 mg  $\text{NH}_4/\text{L}$**
- **pH** and **specific flow rate** on the membrane have high influence on the recover efficiency. **Optimization of pH is still in progress.**
- The local regional temperature of the digestate has been suitable to reach an excellent Ammonia removal/recovery efficiency (**it was not necessary to increase of temperature**)
- Due to the high content of SS (fraction  $< 50 \mu\text{m}$ ), **filter cartridges must be frequently replaced**
- The concentration change of Ammonia in the digestate volume follow a **first-order kinetics** (the calculation of the **mass transfer** coefficient is progress)





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