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REUSE OF TREATED MUNICIPAL WASTEWATER AS A SUSTAINABLE APPROACH TO IRRIGATION AND FERTIRRIGATION IN MEDITERRANEAN COUNTRIES: A CASE STUDY

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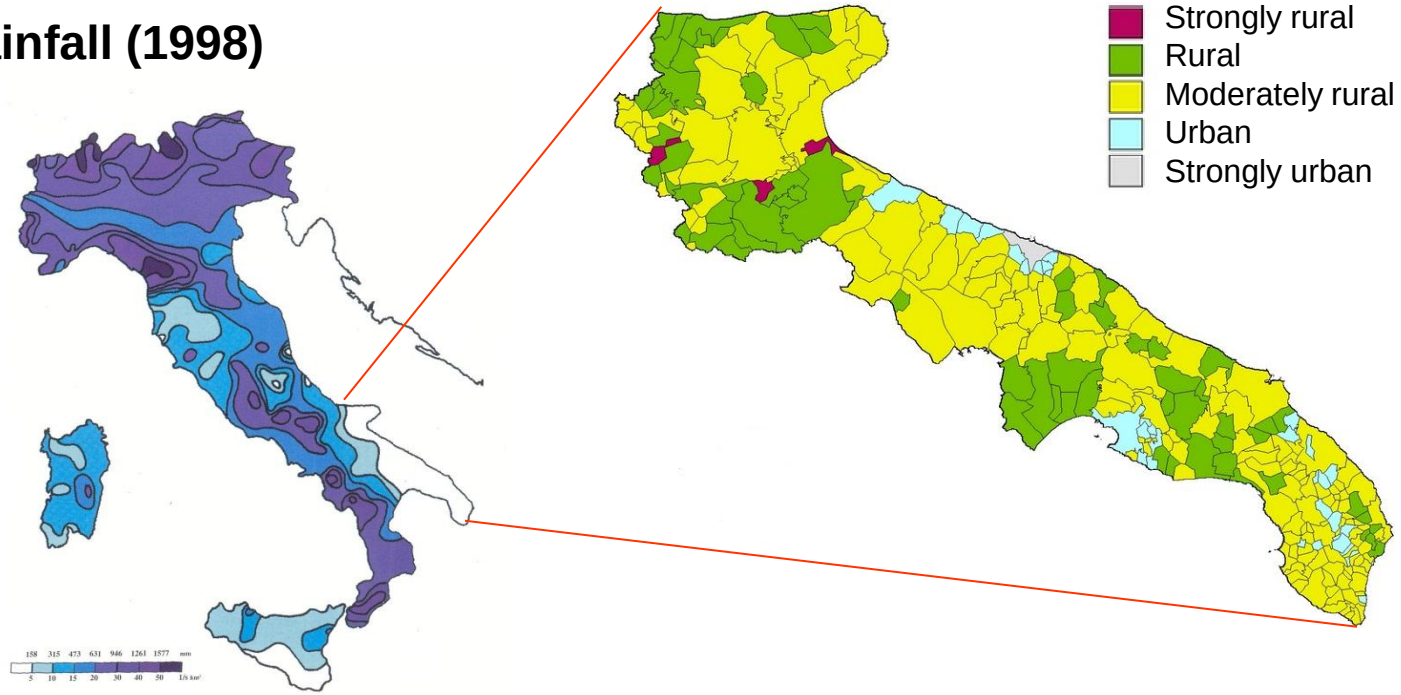
Presentation outlines

1. **Water needs in Apulia region**
2. **Treatment schemes for wastewater reuse**
3. **Case study description**
4. **Performance of the pilot scale IFAS MBR**
5. **Agronomic results**

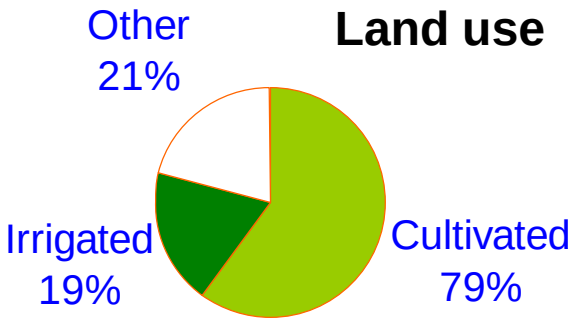
Apulia - Available water and land use

Rainfall (1998)



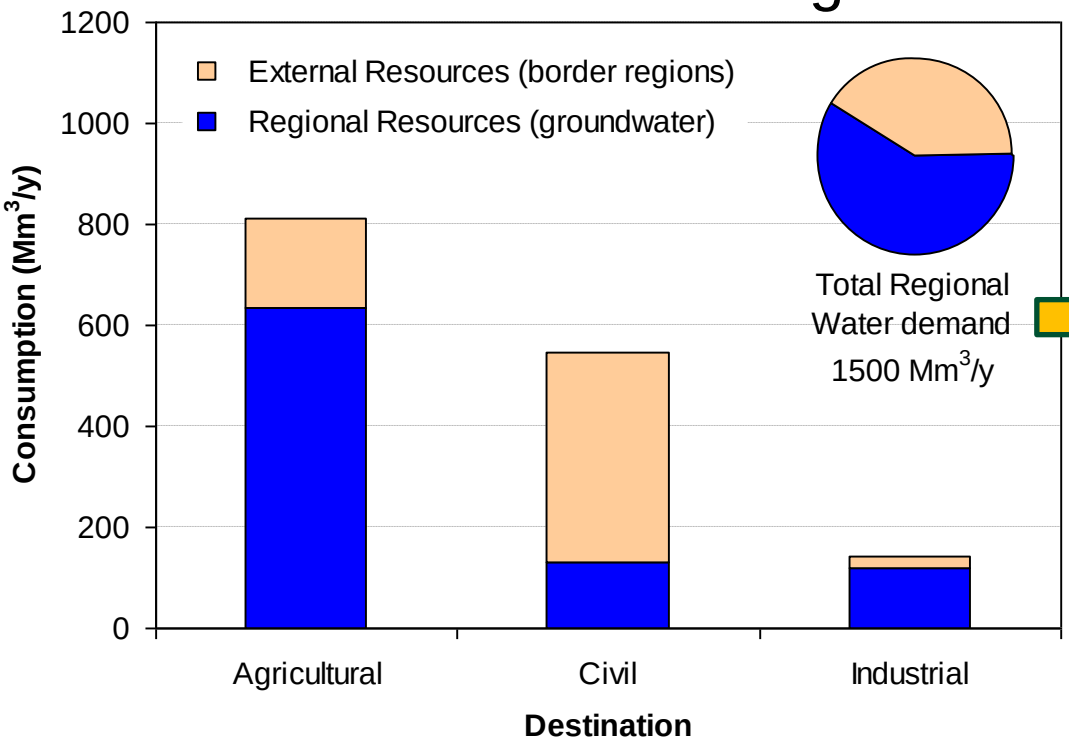
Apulia: 600-650 mm/year
136 m^3/capita per year
absence of permanent rivers/natural lakes

Land use



Apulia - Potential treated wastewater reuse in irrigation

Water demand in Puglia



10% savings of primary water source

Other advantages:

- Nutrients
- Continous availability

Municipal wastewater potentially available for reuse in agriculture:

- Total estimate → 150 Mm^3/year
- Already or almost available (tertiary treatment plants)→ 90 Mm^3/year

Piano di Tutela delle Acque della Regione Puglia (2007) [transl.: Regional Water Protection Plan]

Treated wastewater reuse for irrigation

Opportunities

- Continuous water supply;
- Savings on primary sources;
- Nutrients.

Risks

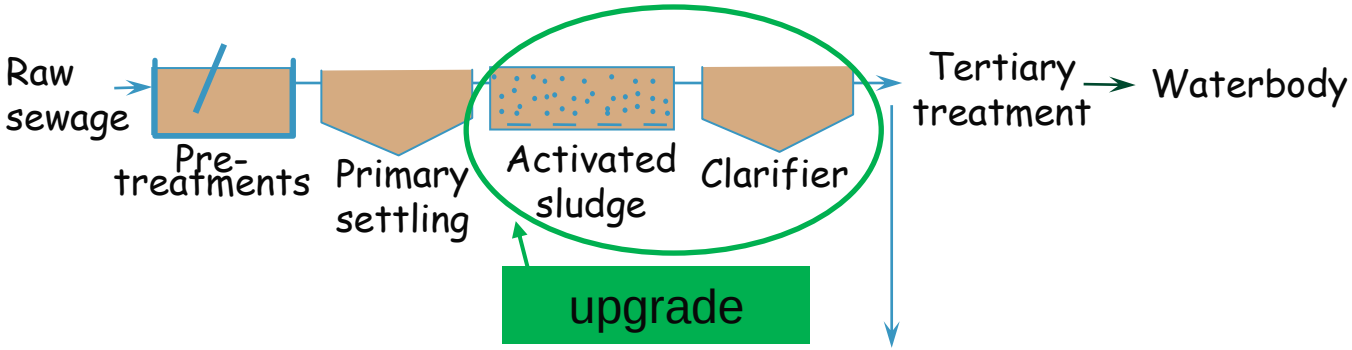
- Microbiological safety;
- Chronic effects on soils;
- Eutrophication of storage basins.

Questions

- Is the cost sustainable ?
- Are technologies adequate ?
- Are limits and regulations representative of local situations ?
- How stakeholders and final users can be involved ?

How to choose the treatment scheme for agricultural reuse 1/2

Conventional wastewater treatment plant



Discharge standards

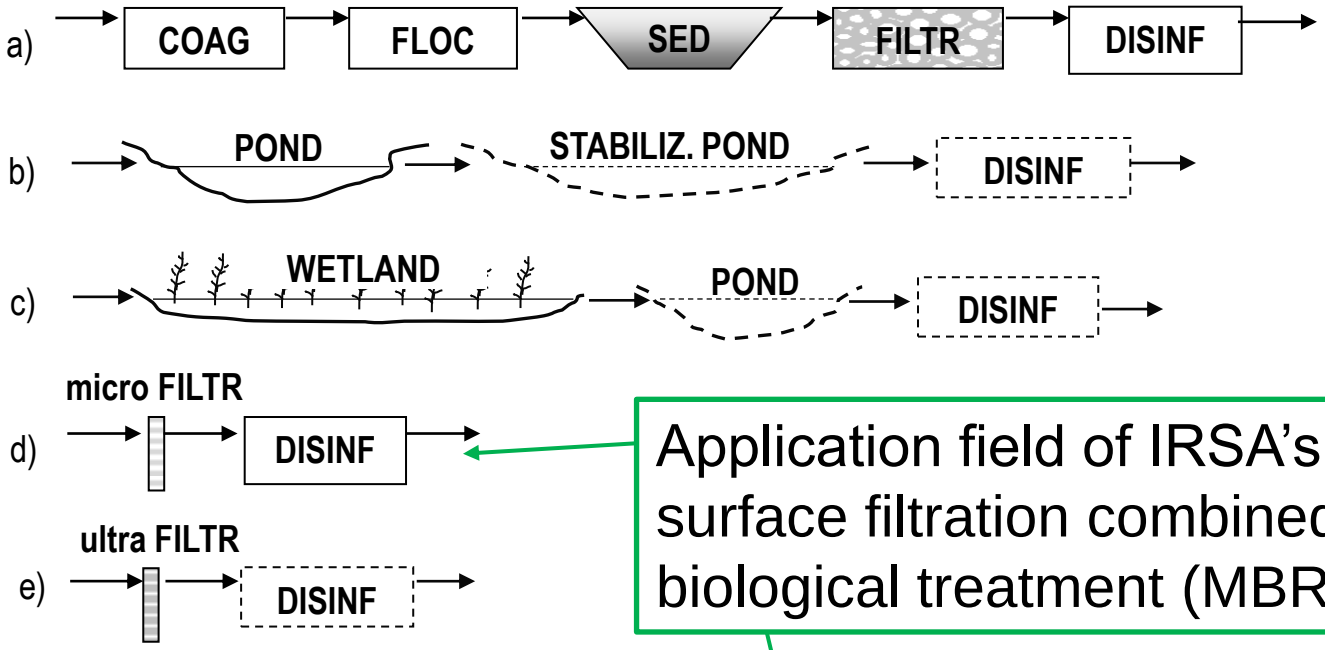
Agricultural reuse standards

How to choose the treatment scheme for agricultural reuse 2/2

Parameters	Concerns	Technologies
Suspended solids	Pipe clogging, Accumul. on soil	Clariflocculation, Filtration (GMF), Membrane filtration
Microrganisms	Hygienic safety	Disinfection, Membrane filtration
Toxic compounds (metals/organics)	Accumulation in soil and crops	Act. carbon adsorption, Clariflocculation
Nutrients (N, P)	Eutrophication of storage basins	Biological treatments, Ammonia stripping, Chemical precipitation

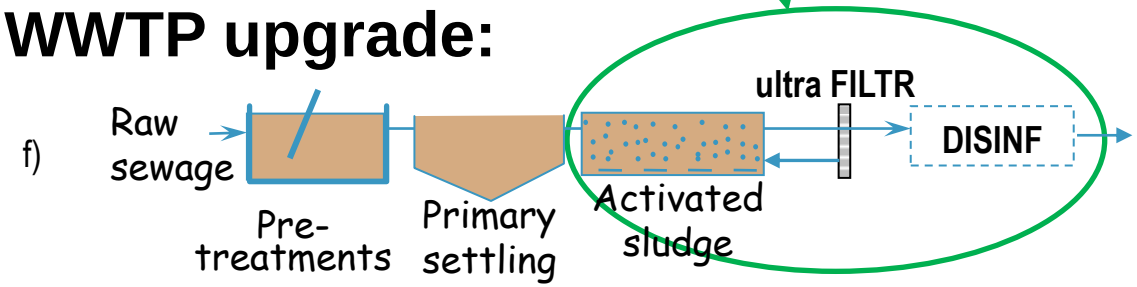
Possible wastewater treatment schemes

Tertiary treatments

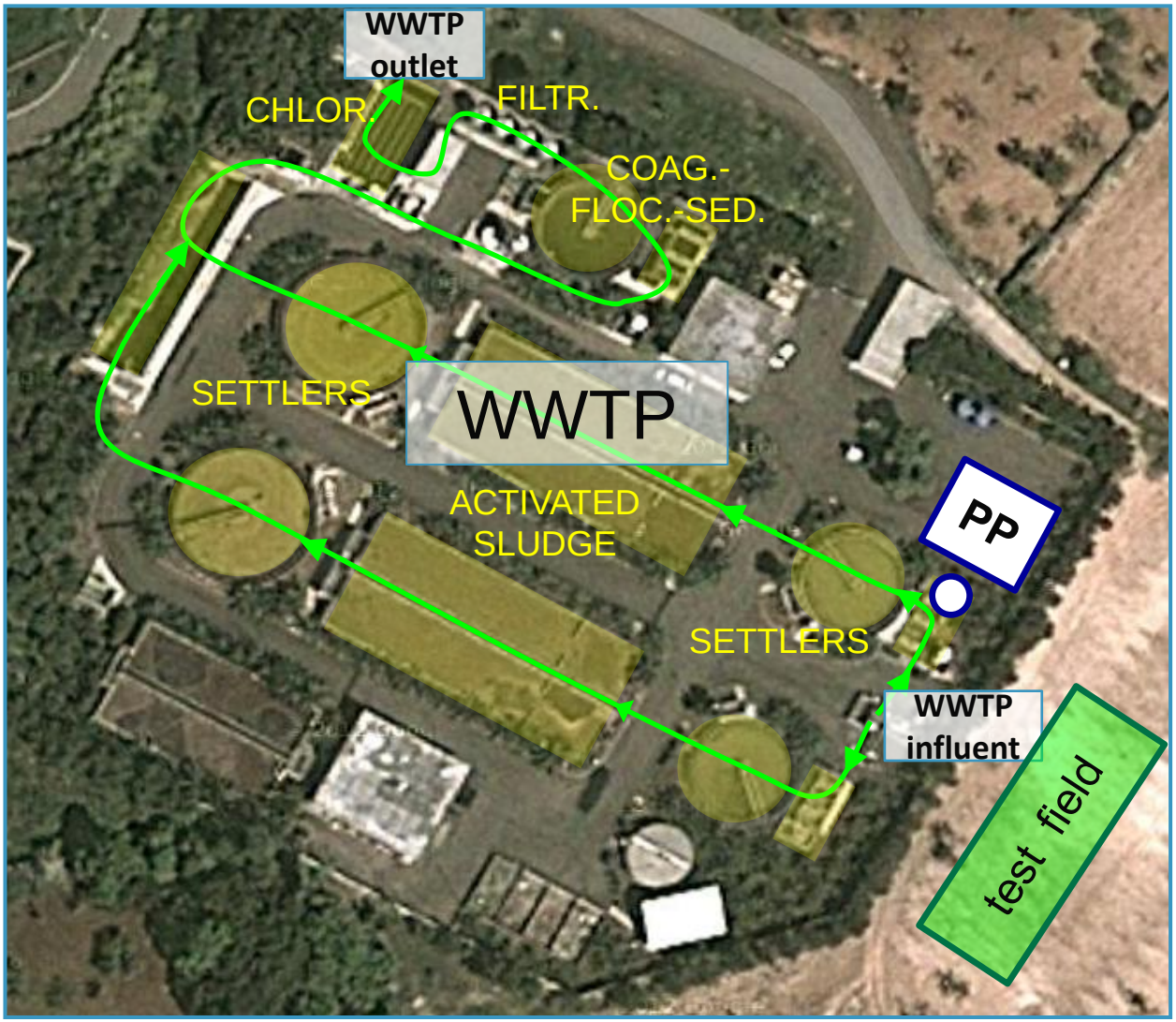


Application field of IRSA's pilot tests: surface filtration combined with biological treatment (MBR)

WWTP upgrade:



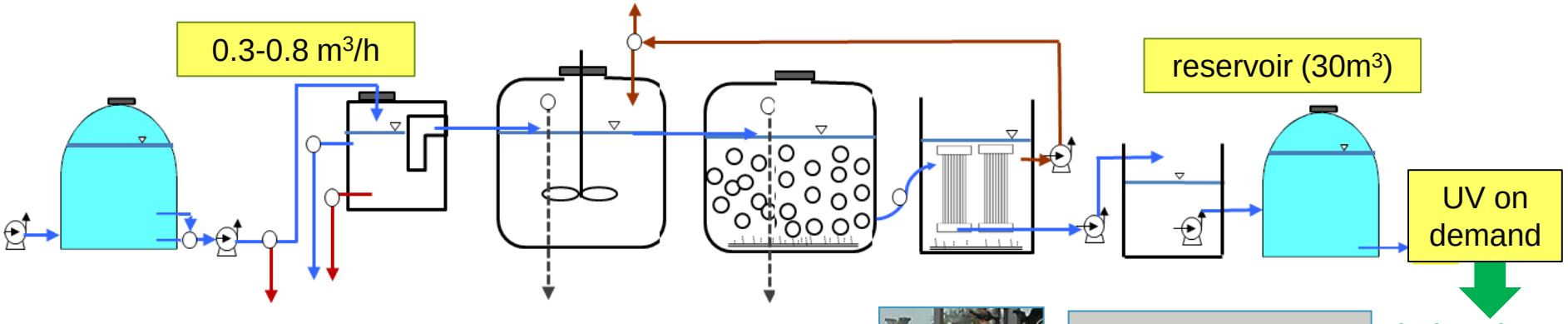
The experimental installations



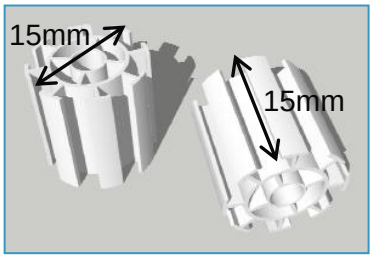
PP) IFAS/MBR + UV Treatment of pre-screened municipal WW

Test field (3000 m²) Horticulture irrigated with treated effluents (including the **WWTP outlet**) and control (well water)

Pilot plant description

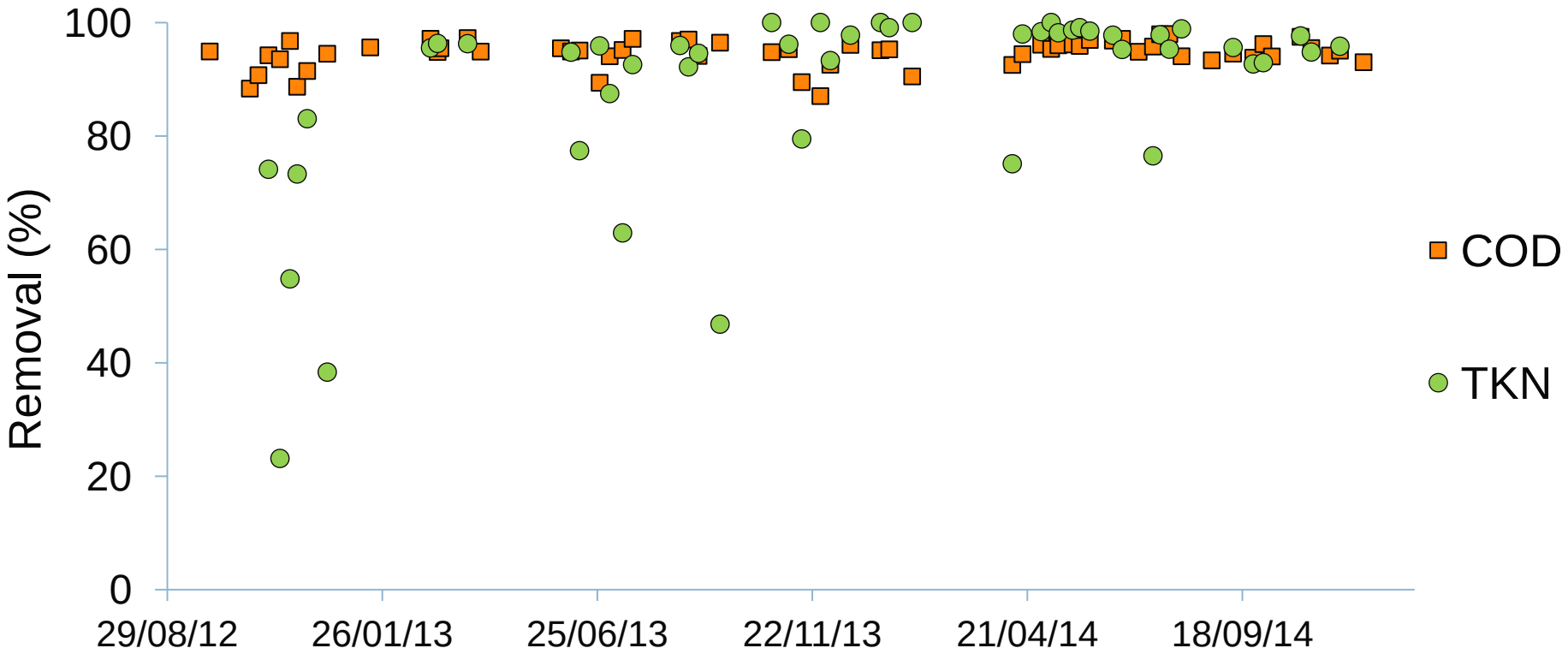


Integrated Fixed film-Activated Sludge Membrane BioReactor (IFAS-MBR)



IFAS-MBR performances

→ Interruptions (carriers clogging) did not affect COD removal, but affected nitrification. However, **nitrification was always recovered in less than one week** after each stop.

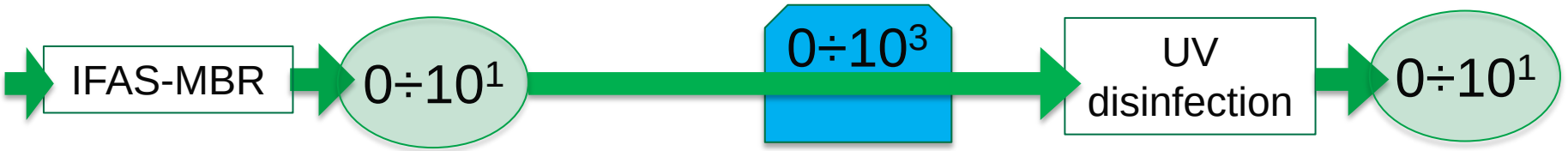


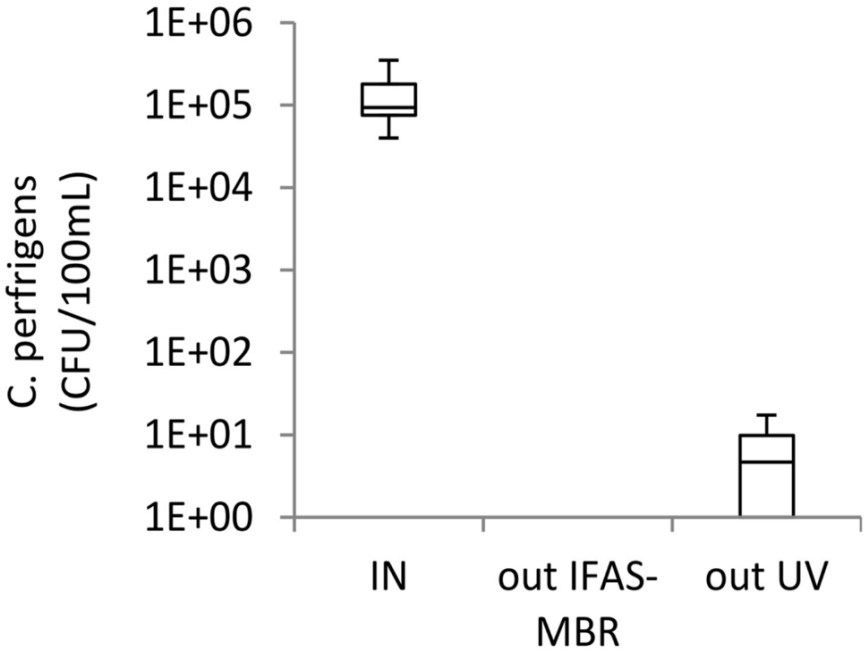
IFAS-MBR + UV: pathogen indicators removal

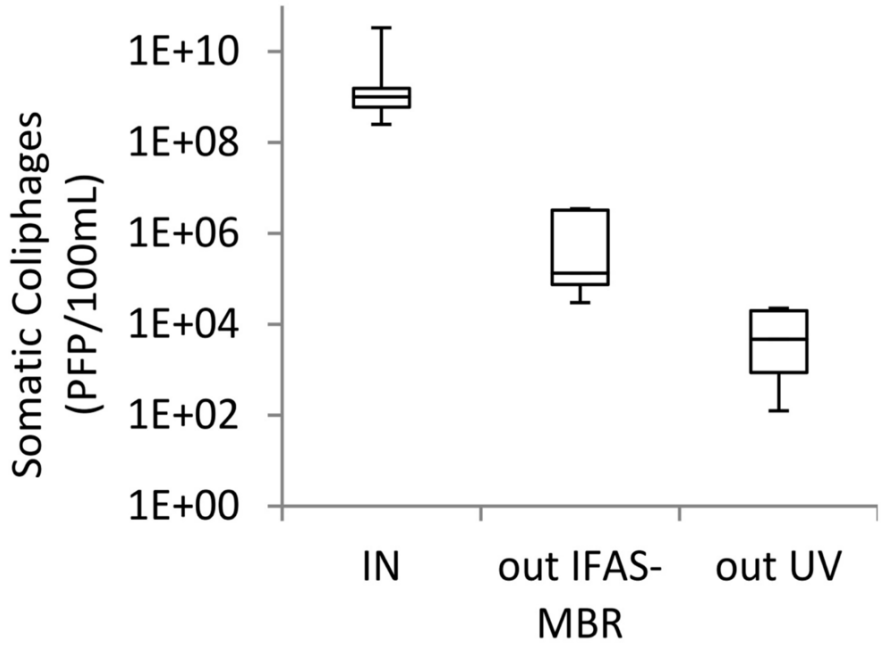
out IFAS-MBR
E. Coli (CFU/100mL)

permeate storage tank
E.Coli (CFU/100mL)

out UV
E. Coli (CFU/100mL)







Water sources adopted for irrigation (2-years averages)

Parameter	Control	WWTP effluent	PP effluent	Local limits for reuse
EC (µS/cm)	888±420	989±170	764±88	3000
pH (-)	7.5±0.3	7.7±0.2	7.1±0.5	6.0-9.5
COD (mgO_2/L)	<15	67.1±55.4	19.5±5.4	100
NH_4^+ (mgN/L)	<2	<2	2.6±7.0	2
NO_3^- (mgN/L)	1.5±1.5	6.4±5.6	29.2±17.1	35(*)
Total Phosphorus (mgP/L)	0.4±0.7	4.2±5.5	8.1±4.3	10
TSS (mg/L)	<2	4.8±1.0	<2	10
Free Chlorine (mg/L)	<0.2	<0.2	<0.2	0.2
SAR (-)	0.9±0.8	1.1±0.1	0.8±0.1	10
E. coli (CFU/100mL)	0±0	872±1292	0±1	10(**)
Salmonella spp	Absent	Absent	Absent	Absent

(*) Limit related to Total Nitrogen.

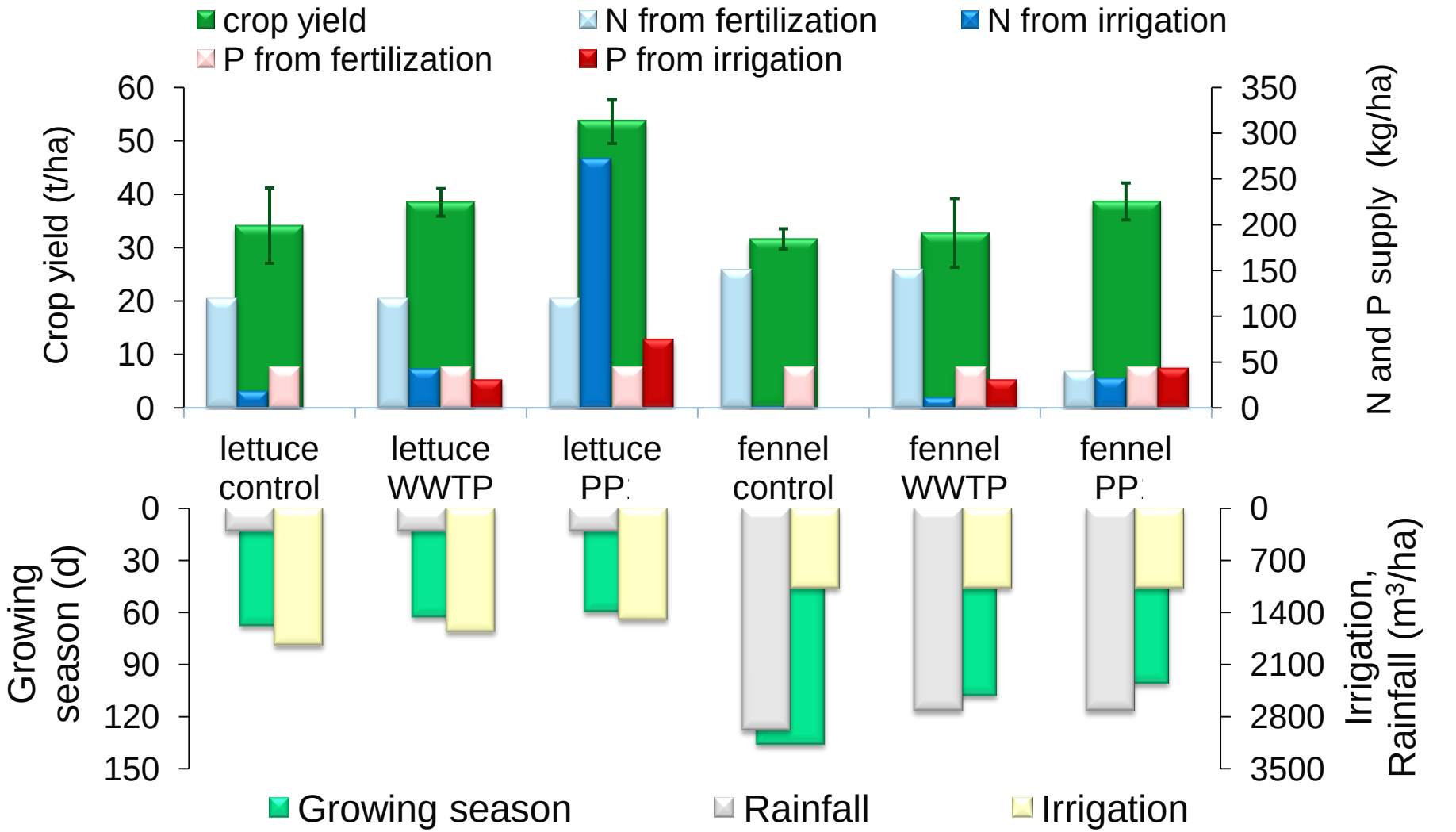
(**) Limit that has to be respected by 80% of the samples (maximum value=100 CFU /100mL).

Test field

Sept 2013-Jan 2014
Fennel Cv. Archimede - Single rows, 10 plants/m^2
Drip irrigation - Irrigation threshold: 16 mm ETc

Apr-Jun 2013
Lettuce Cv. Canasta - Single rows, 6.7 plants/m^2
Drip irigation - Irrigation threshold: 10 mm ETc

Agronomic results - productivity



Agronomic results – Faecal indicators at harvesting time

Salmonella: always **absent** in water, soil and edible parts

		Escherichia coli		
		Water (CFU/100mL)	**Soil** (CFU/1g)	**Edible parts** (CFU/1g)
	Control	0	0	0
	WWTP	10^2-10^3	0	0
	PP	0-10	0	0
	Control	0	0	0
	WWTP	10^2-10^3	<1	4
	PP	0-2	0	0

Conclusions

Two treatment schemes applied to the same municipal WW →

Significant differences in terms of suspended solids and faecal indicator removals. The pilot plant, based on ultrafiltration and UV radiation, had better performance for producing water suitable for agricultural reuse (e.g. complying with local laws).

Operating the WW treatment (biological process) for partial nitrogen removal **(nitrification)** allowed the supply of a consistent **fertilization contribution with the irrigation water**. →

This had **positive effects on yield and growth rate** of both lettuce and fennel, without affecting the quality of crops.

Thanks for your attention

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www.water4crops.org Euro-India collaborative project

www.pon-interra.it Italian National project

IFAS-MBR operation

Problems related to the presence of the **carriers**

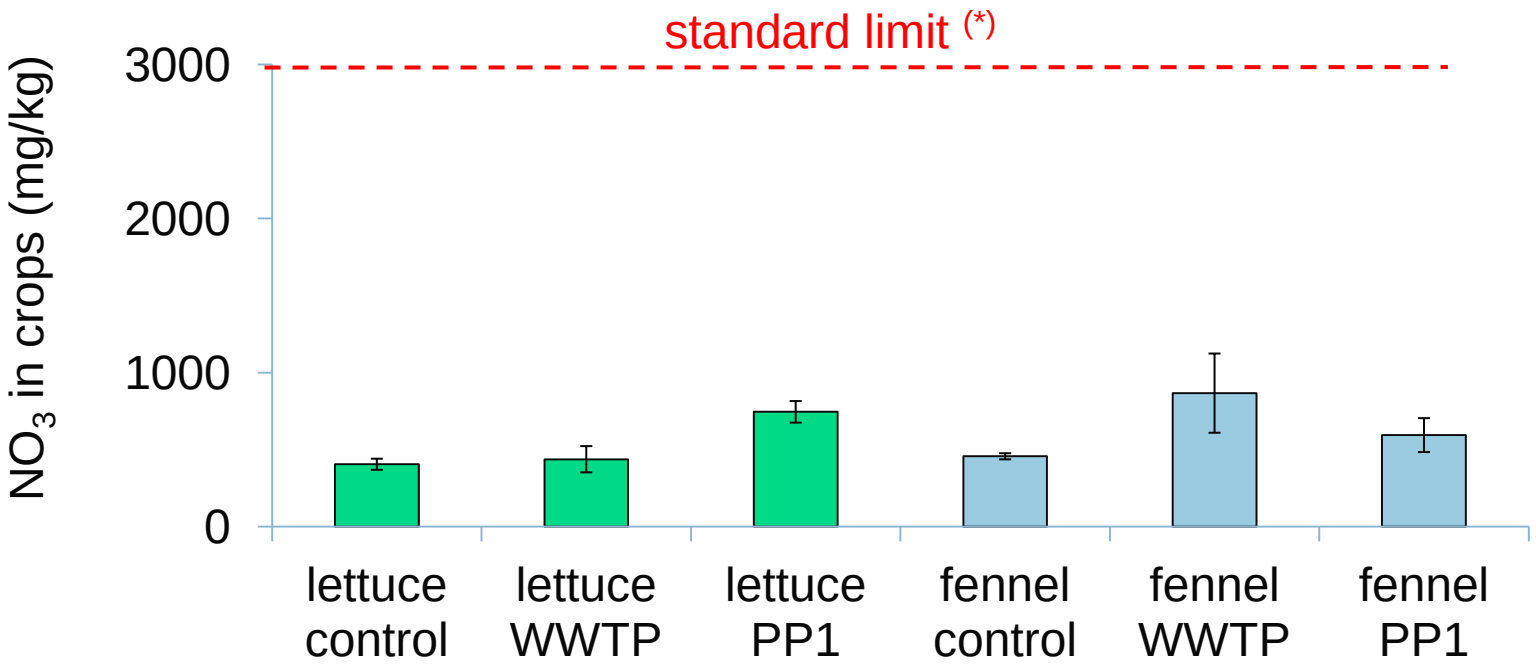
→ **Clogging** in several points of the plant required **changes in piping and pumping** in the first months after start-up.

→ Steady state conditions for biological processes were reached only some months after start-up.

→ Interruptions of the pilot plant operation caused membrane **fouling** and a loss of membrane productivity (from 800 L/h to 300 L/h).

→ The biofilm attached to the carriers decreased consistently with the flow rate, indicating that the **biofilm growth** is significantly **limited under very low organic loading rates** (0.15 gCOD/gVSS/d).

Agronomic results
Nitrate in crops



(*) EU Commission Regulation No 1258/2011 of 2 December 2011