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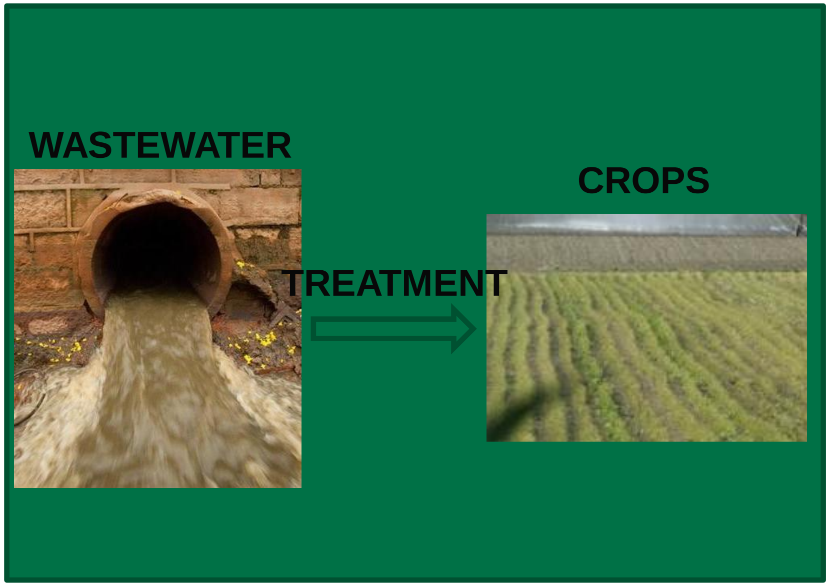
IRSA CNR

MUNICIPAL WASTEWATER REUSE IN AGRICULTURE BY AN INNOVATIVE REACTOR WITH LOW ENVIRONMENTAL IMPACT



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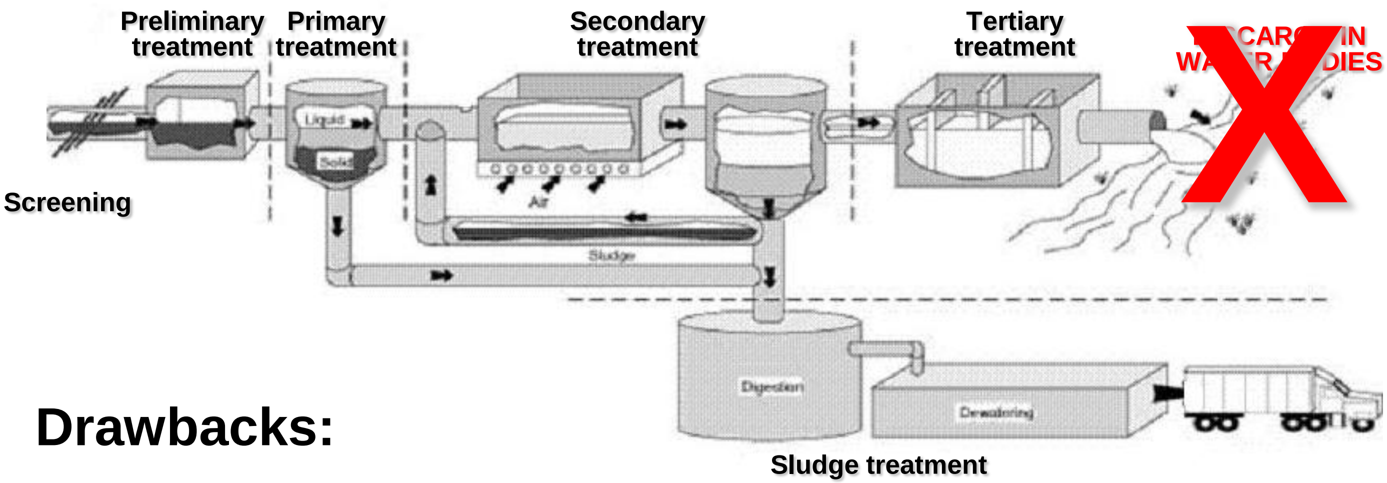
Water4Crops

Conventional treatment line



CROPS IRRIGATION

Drawbacks:

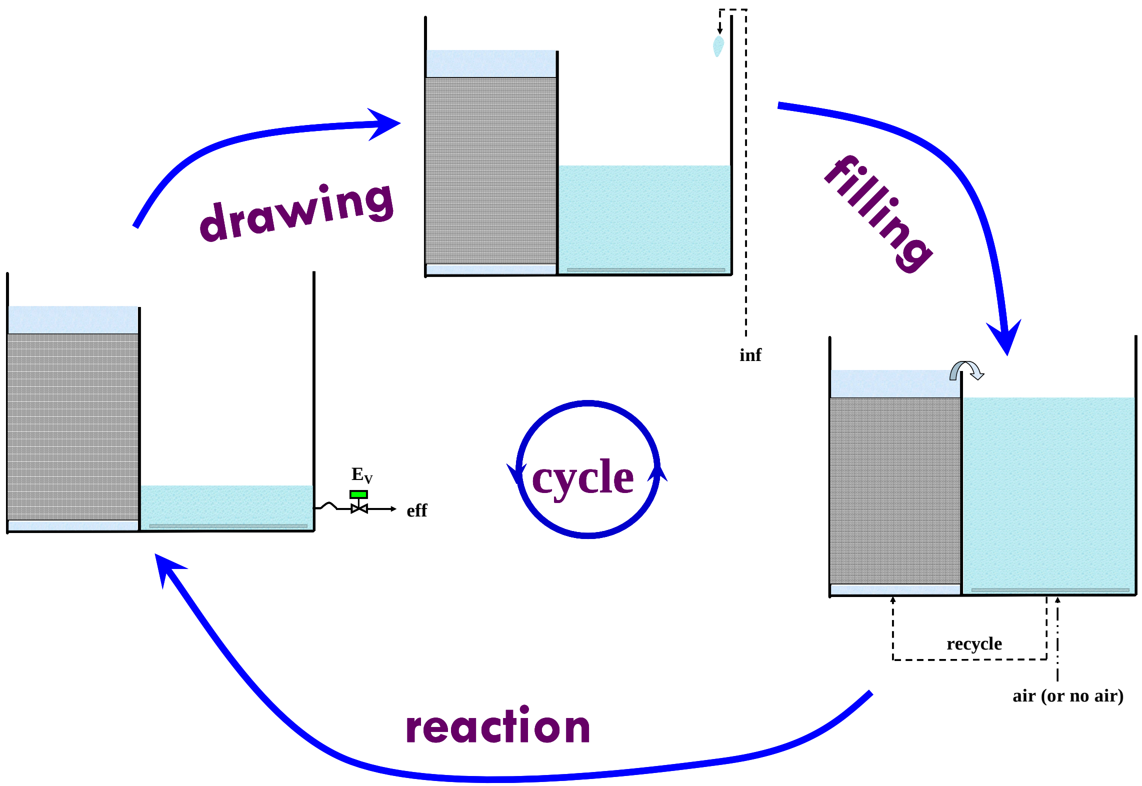
- **Low settling speed (< 1 m/h)**
- **Low organic load rate (< 1 kgCOD/m^{3}d)**
- **High sludge production (40-60 g/PE·d)**
- **Low flexibility**
- **Tertiary chemical or physical disinfection**
- **High area requirement**

Treatment based on Sequencing Batch Biofilter Granular Reactor

In comparison with the conventional treatment systems, SBBGR technology is able to:

- **Perform in a single stage the entire wastewater treatment train;**
- **Offer higher operational flexibility and robustness;**
- **Treat higher organic load rate;**
- **Reduce the sludge production (up to 80%);**
- **Produce an excess sludge already stabilized;**
- **Produce a high quality effluent;**
- **Reduce area requirement.**

SBBGR operation



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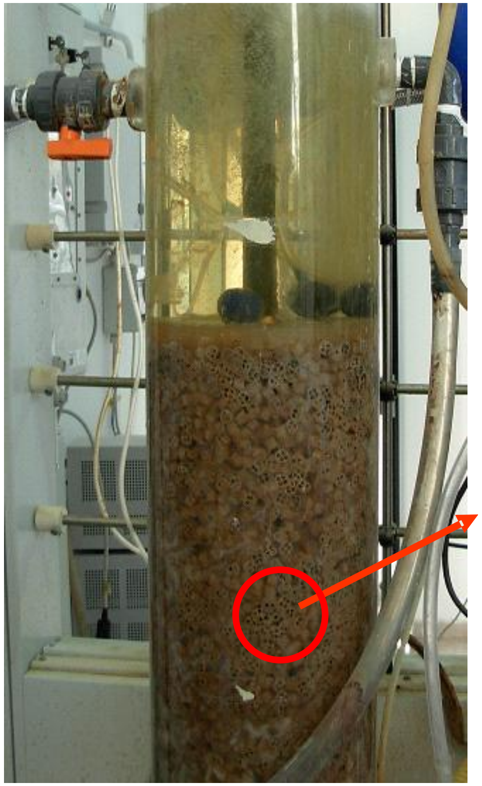
SBBGR operation - What makes SBBGR better?

Recirculation flow generates shear stress into packed zone of SBBGR



BIOFILM

GRANULES

- High biomass concentration (30-50 kg/m^3)
- High sludge retention time (≥ 200 d)

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Aims and scope

Treatment and reuse in agriculture of wastewater produced by small communities

Monitored parameters

- **Physical and chemical:** COD (Chemical Oxygen Demand), suspended solids, nitrogen, phosphorus, pH, SAR (Sodium Adsorption Ratio), conductivity.
- **Microbiological:** Faecal Contamination Indicators (*E.coli*, *Clostridium perfingens* spores, Somatic coliphages), relevant pathogenic Protozoa (*Cryptosporidium parvum* and *Giardia lamblia*) and *Salmonella*.

ITALIAN microbiological requirements:

- ***E. coli*: 10 CFU/100 mL** (< 100 CFU/100 mL in 80% of samples)
- ***Salmonella*: absent**

Strategy for wastewater reuse

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SBBGR

Sand filter

Physical disinfection (UV irradiation)

Hg – low pressure lamp

Emission peak: 254 nm

UV fluency: ~ 40 mJ/cm^2

Chemical disinfection (Peracetic acid - PAA)

PAA + H_2O_2 solution

Tested concentration: 1 mg PAA/L

Reaction time: 30 min

Process evaluation

Monitored parameters

Physical and chemical parameters:

- Wastewater
- SBBGR effluent (biological treatment only)

Microbiological parameters:

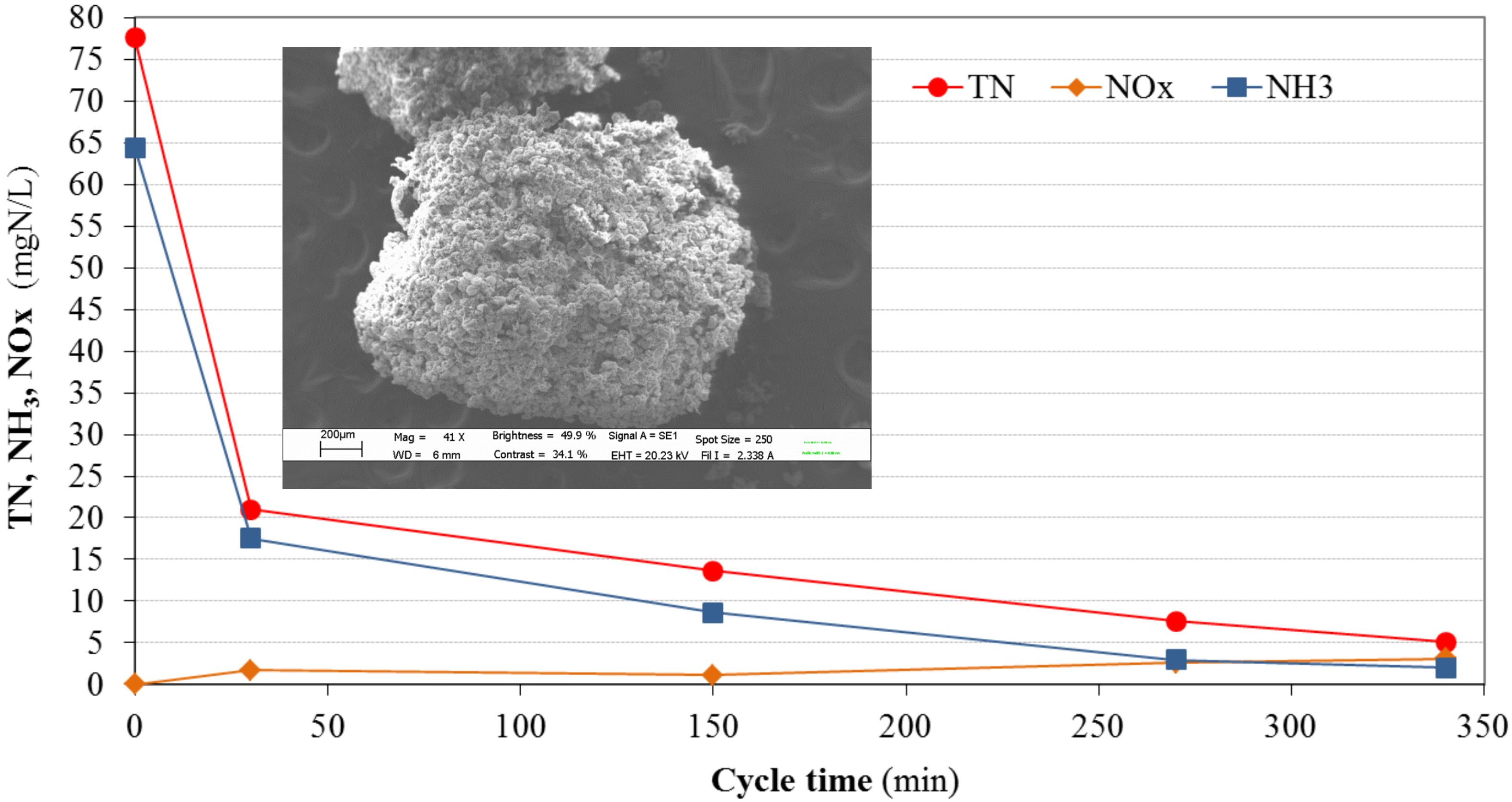
- Wastewater
- SBBGR effluent (biological treatment only)
- SBBGR + Sand filter effluent
- Physical disinfection effluent (UV)
- Chemical disinfection effluent (PAA)

Physical and chemical parameters

Parameter		Mean value ± standard deviation
TSS	Influent [mg/L]	**295 ± 596**
	Effluent [mg/L]	**10 ± 10**
	Removal [%]	**95 ± 5**
VSS	Influent [mg/L]	**259 ± 537**
	Effluent [mg/L]	**8 ± 8**
	Removal [%]	**97 ± 3**
COD	Influent [mg/L]	**602 ± 674**
	Effluent [mg/L]	**38 ± 17**
	Removal [%]	**93 ± 3**
NH_4^+	Influent [mg/L]	**52 ± 19**
	Effluent [mg/L]	**2 ± 5**
	Removal [%]	**96 ± 8**
TN	Influent [mg/L]	**73 ± 26**
	Effluent [mg/L]	**17 ± 9**
	Removal [%]	**77 ± 11**
P_{tot}	Influent [mg/L]	**11 ± 5**
	Effluent [mg/L]	**4 ± 1**
	Removal [%]	**52 ± 27**

Physical and chemical parameters

Nitrogen removal



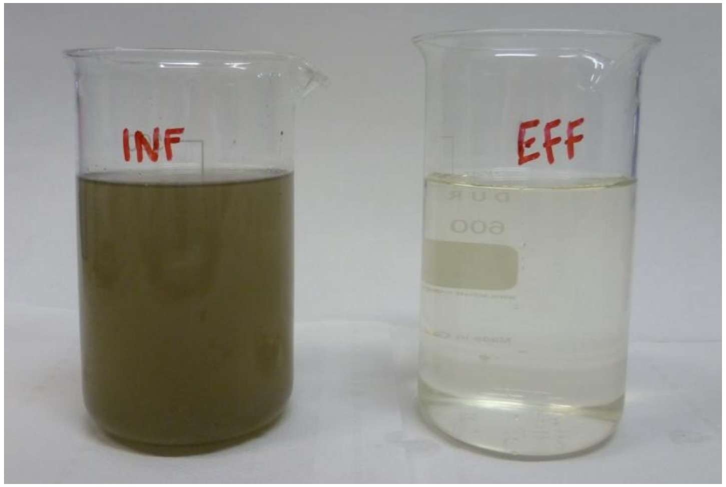
Physical and chemical parameters

Parameter		Mean value ± standard deviation
pH	Influent	**7.4 ± 0.2**
	Effluent	**7.8 ± 0.2**
Conductivity	Influent [μS/cm]	**1223 ± 178**
	Effluent [μS/cm]	**892 ± 99**
SAR	Influent	**2.3 ± 0.5**
	Effluent	**2.7 ± 0.1**

Italy: < 3000 μS/cm

Italy: < 10

Wastewater SBBGR effluent

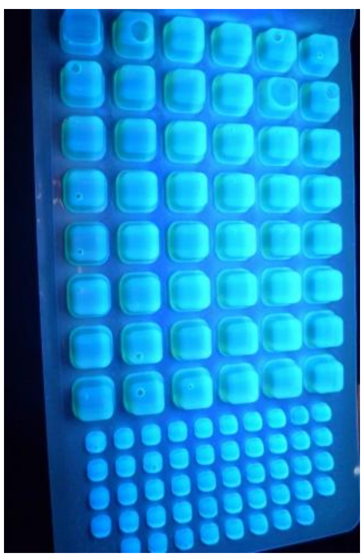


SBBGR DISINFECTION

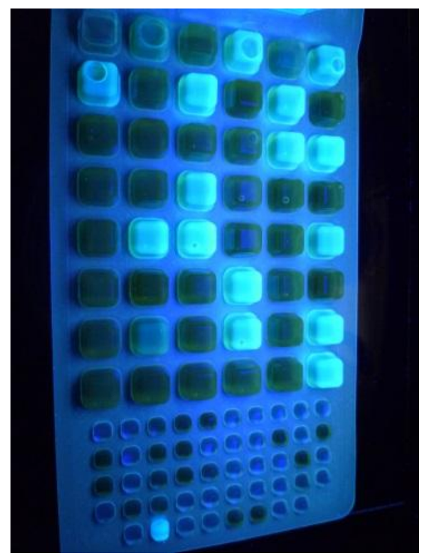
Bacteria

E. coli

Influent
(1:100 dilution)
(> 2.4 · 10^5 MPN/100 mL)



Effluent
(1:10 dilution)
(2.0 · 10^2 MPN/100 mL)



WHO - reuse:
E. coli < 10^3
CFU/100mL

Italy - Discharge in water bodies:
E. coli < 5 · 10^3
CFU/100mL

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SBBGR DISINFECTION

Virus and protozoa

Parameter		Mean value ± standard deviation
Somatic coliphages	Influent [PFU/100mL]	**3.1 ± 3.4 · 10^5**
	Effluent [PFU/100mL]	**1.6 ± 1.7 · 10^4**
	LUR	**1.3 ± 0.1**
Giardia lamblia cysts	Influent [Cysts/L]	**1.3 ± 1.6 · 10^3**
	Effluent [Cysts/L]	**2.9 ± 3.6 · 10**
	LUR	**1.5 ± 0.9**
Cryptosporidium parvum oocysts	Influent [Oocysts/L]	**4.7 ± 4.7 · 10^1**
	Effluent [Oocysts/L]	**0.7 ± 0.5**
	LUR	**1.8 ± 0.3**

SAND FILTER DISINFECTION

Pa

E.

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pe

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Gi

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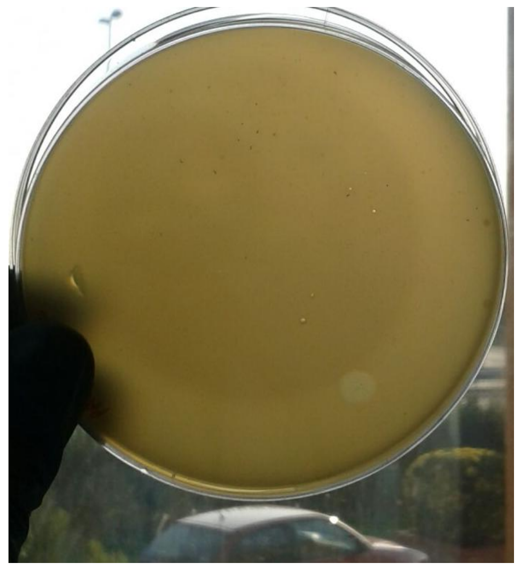
pa

Sa

Somatic coliphages

SBBGR effluent ($8 \cdot 10^3$ PFU/100 mL)	Sand filter effluent ($1 \cdot 10^2$ PFU/100 mL)
	

France: 250 - 10000 CFU/100mL
Spain: 100-1000 CFU/100mL

SBBGR + Sand filter: 2.6 log units

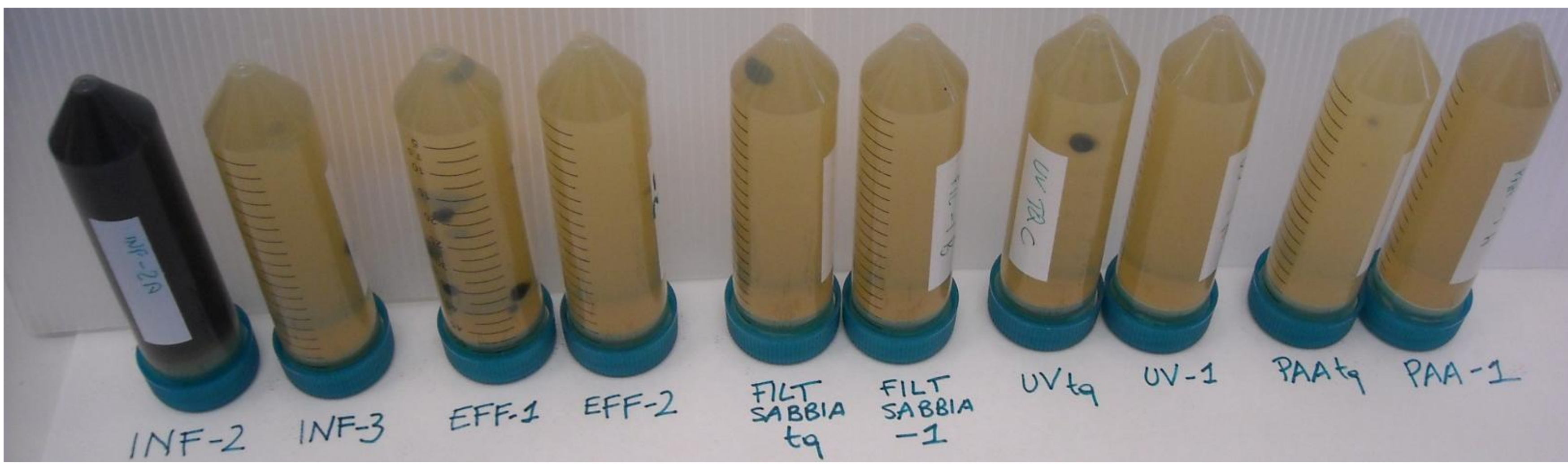
SBBGR + Sand filter: 3.2 log units

TERTIARY DISINFECTION

Parameter		UV (40 mJ/cm^2)	PAA (1 mg/L)
		Mean value ± standard deviation	**Mean value ± standard deviation**
E. coli	Effluent [MPN/100mL]	**5.6 ± 5.3**	**Never detected**

Clostridium perfringens spores

Wastewater **SBBGR eff.** **Sand filter eff.** **UV** **PAA**



Conclusions

- Physical and chemical quality of SBBGR effluent are compatible with agricultural reuse.
- SBBGR acts as a good disinfection system.
- The average *E. coli* content in the effluent of SBBGR would allow its reuse according to WHO criteria or discharge in water bodies according to the Italian requirements.
- The integration of SBBGR with sand filter increased microbiological quality of the effluent for all the monitored parameters (1.0-1.9 log units) and it complies quality criteria of several countries.
- SBBGR + sand filter reduced protozoa concentration to less than 1 cysts/L.
- Tertiary disinfection by UV (fluency 40 mJ/cm^2) or PAA (1 mg/L) reduced the *E. coli* content below 10 CFU/100mL (Italian limit for agricultural reuse).

Questions?

THANK YOU FOR YOUR ATTENTION