Use of reclaimed waste**water** from **AnMBR** for food production

Peiying Hong
Ramona Marasco
Yutao Shen

WATER is **essential** for life and **cannot** be **replaced**

What we can do is

ADJUST and SAVE

by applying technology to make it suitable and controlling its use

&

RE-USE

Clean what we are discarding

sustainability

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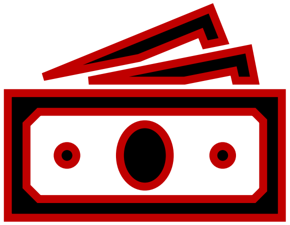
Article

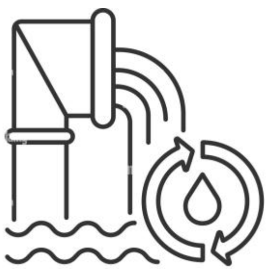
Enhancing Treated Wastewater Reuse in Saudi Agriculture: Farmers' Perspectives

Rady Tawfik [1], Khalid G. Biro Turk [2,*], Mohammad Alomair [3], Salah Sidahmed [3], Randah M. Alqurashi [4], Ammar Ebrahim [5], Mohamed El-Kafrawy [3], Sidiq Hamad [4] and Emad Al-Karablieh [6]

factors influencing farmers' acceptance of TTW reuse in Saudi Arabia. Drawing on survey data across five agriculturally significant regions, the analysis reveals that while a majority of farmers are willing to use TWW—primarily driven by water scarcity and limited alternatives—perceptions of quality, safety, and economic benefit condition this willingness. Positive perceptions of TWW's impact on productivity, cost savings, and fertilizer reduction significantly enhance its acceptance. However, concerns about pest incidence, health risks, and consumer resistance persist, particularly in regions where negative experiences or limited infrastructure have shaped attitudes. These concerns, if unaddressed, could undermine broader efforts to scale the use of non-conventional water resources in agriculture. Ultimately, the successful integration of TWW into Saudi Arabia's agricultural water portfolio will require a multi-dimensional strategy that combines technological investment, institutional support, and participatory engagement with the farming community. Only through such an integrated approach can the Kingdom move toward a more sustainable and resilient agricultural future in the face of mounting water scarcity.



Wastewater in Saudi Arabia

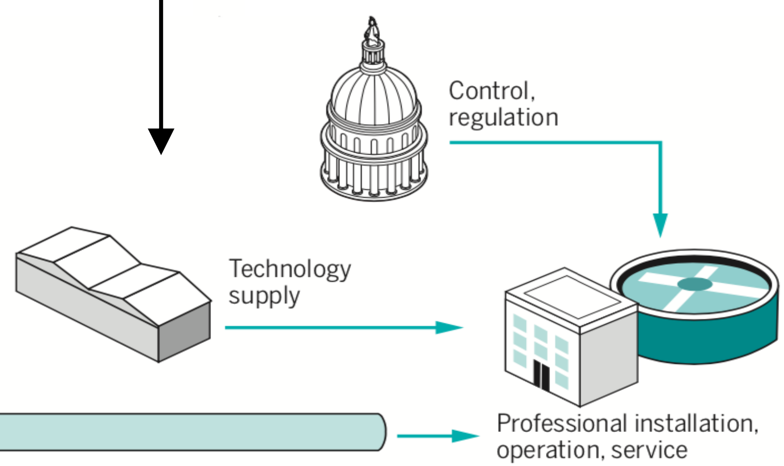


Wastewater daily flow is estimated to be
4.2 million m³

≈ 4.2 billion litres
> 1,500 Olympic pools

If we use **ALL treated water**, this would have met approximately **10%** of the agricultural needs
57.1 million m³

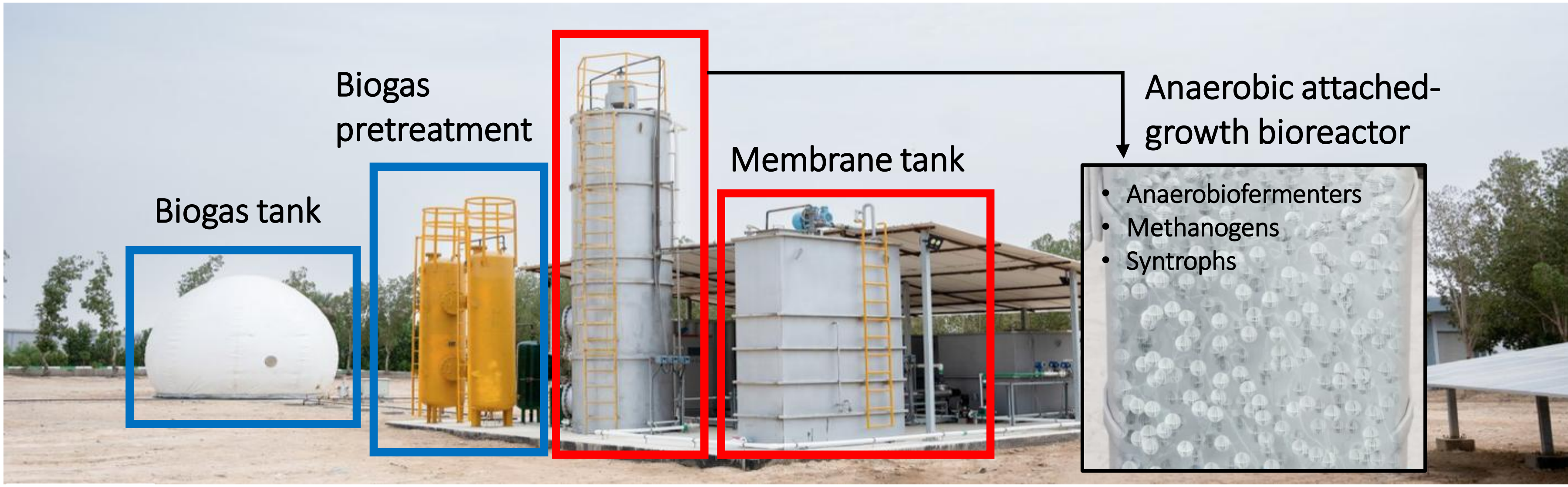
*FAO 2008, **Global Agriculture, 2020



- The current sewage network covers about 50%* of the total wastewater generated
- The remaining fraction of wastewater is unused and discharged into the environment*
- **95%–100% coverage** would be **required by 2030**

Dawoud et al. (2022) *Desalination and Water Treatment* 263: 127–138

Anaerobic Membrane BioReactor (AnMBR)



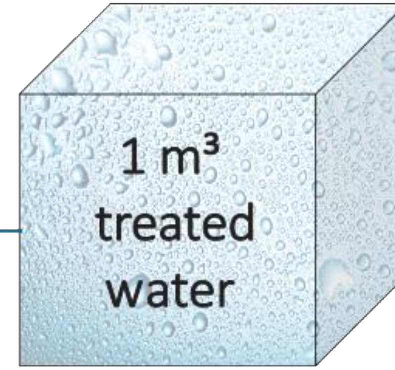
Capacity of **50 m^3/d** – 2 years long-term continuous operation, **municipal** and **industrial influent**

Low Energy cost	Low Waste	Low C-Footprint	High Resource
1.4 kWh/m^3 produced	**93% less sludge** than aerobic TWWPs	Low emission **0.33 kg eq/m^3**	Nutrient recovery (N, P)

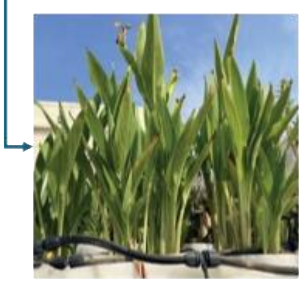
What are the properties of JEDDAH AnMBR-TWW?

The TWW from the AnMBR is a clean effluent that remains rich in nutrients:

>60 mg/L NH_4^+ and **4 mg/L PO_4-P**

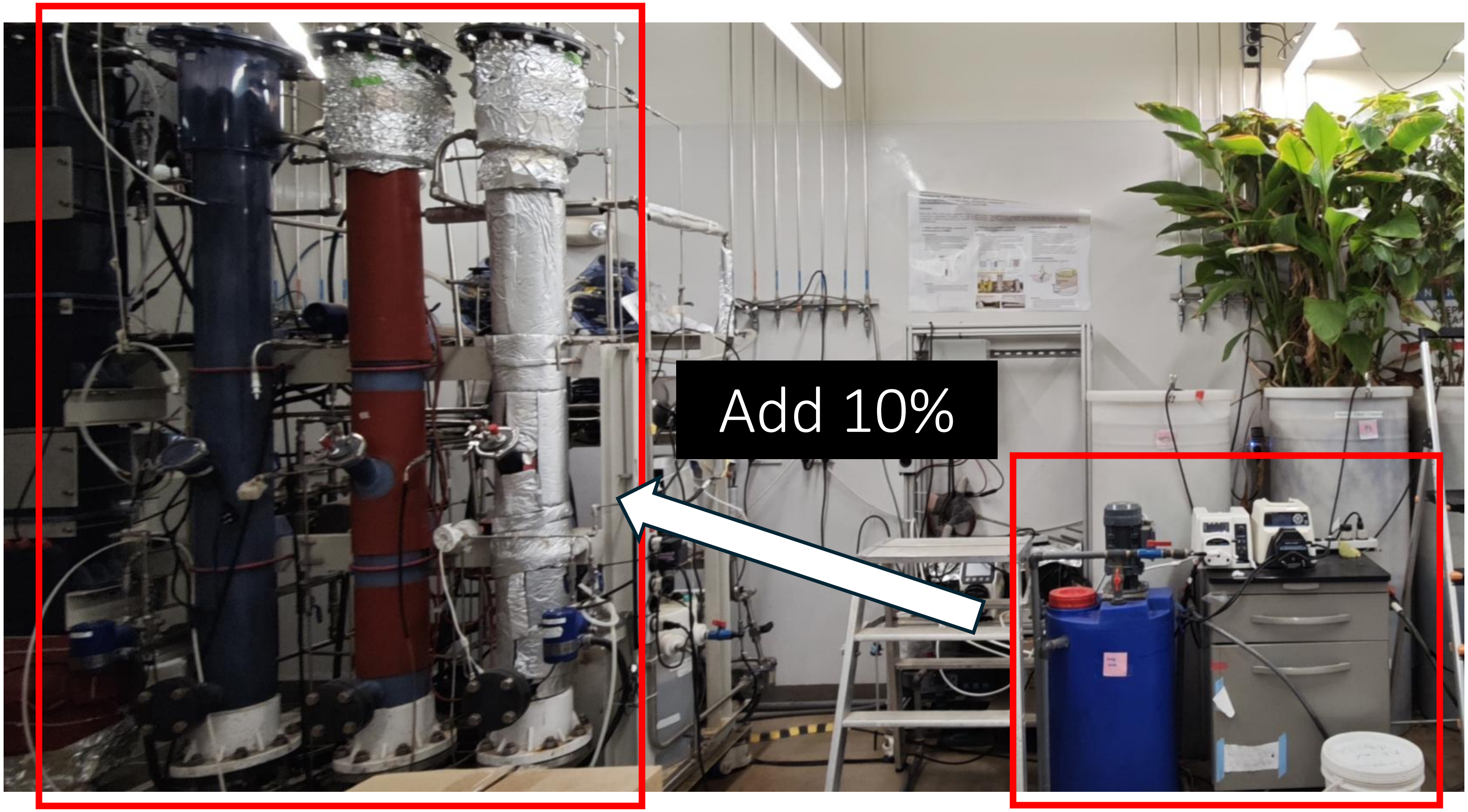


1.4 kWh
Energy is produced



≈62 g N
≈4 g P
Liquid fertilizer is obtained

What are the properties of KAUST AnMBR-TWW?



KAUST AnMBR – 50 L/day
(influent from KAUST only)

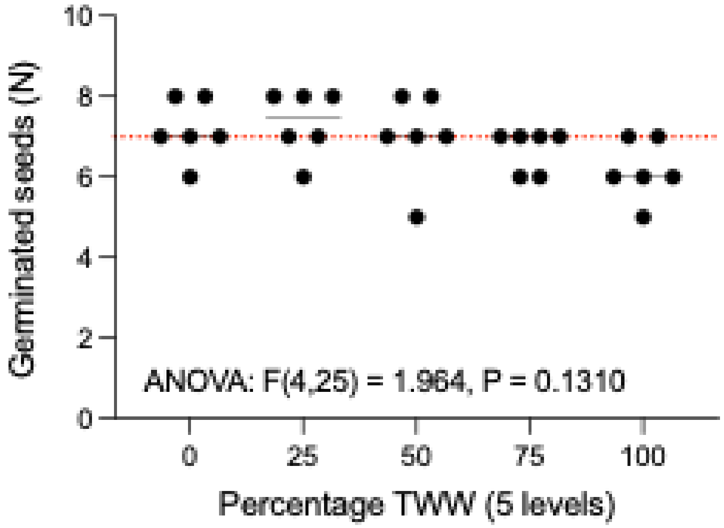
Leachate of Edama compost
(It is another type of **WASTE**
rich in organic matter)

What are the properties of KAUST AnMBR-TWW?

Parameter	TWW
NH_4^+-N	**31.3**
NO_3^--N	0.950
NO_2^--N	0.083
TN	28.9
PO_4^{3-}-P	**4.62**
pH	6.74
COND	1148
TDS	607
Sal	580
Ca^{2+}	**102**
Mg^{2+}	**99**
K^+	**265.5**
COD removal	>70%

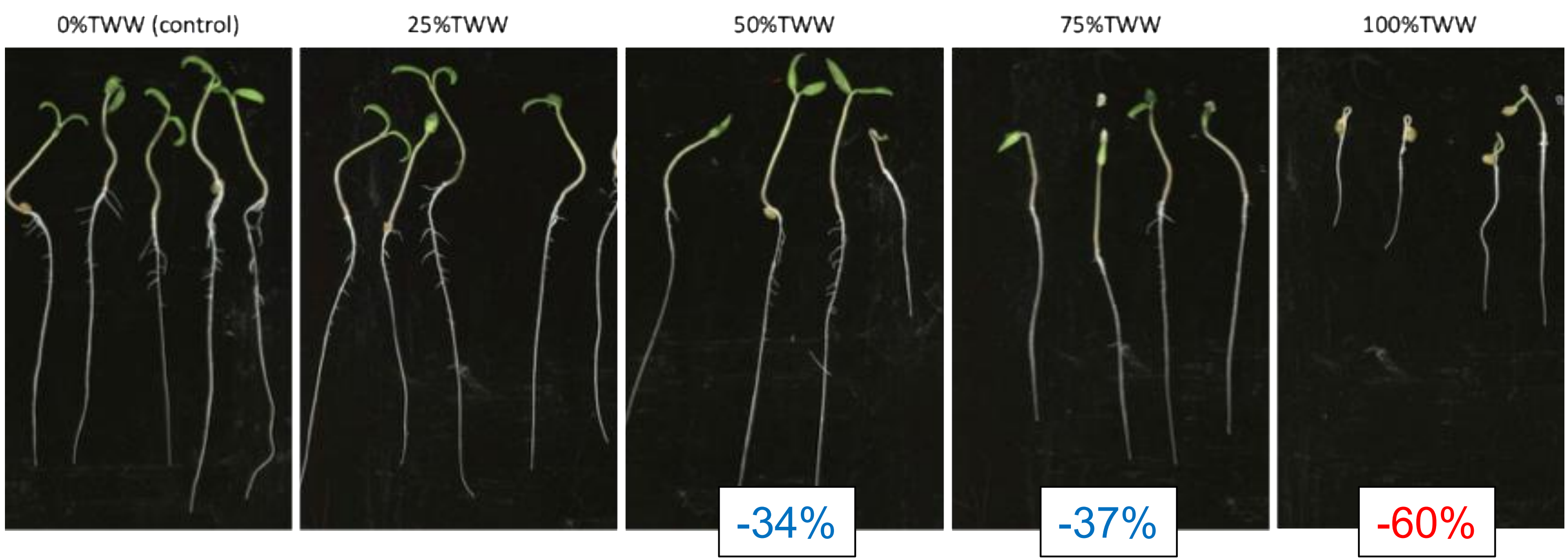
What is the effect of AnMBR-TWW on plants?

Can TWW AnMBR TWW be used from germination?



5 levels of Jeddah AnMBR-TWW tested:
0%, 25%, 50%, 75% and 100%

Germination is not directly affected,
but early seedling growth is reduced,
i.e., lower fresh biomass from 50% TWW



Can we overcome such “stress” by treating plants with beneficial bacteria?

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DOI: 10.1111/1751-7915.70043

MICROBIAL BIOTECHNOLOGY Open Access

RESEARCH ARTICLE

Desert-adapted plant growth-promoting pseudomonads modulate plant auxin homeostasis and mitigate salinity stress

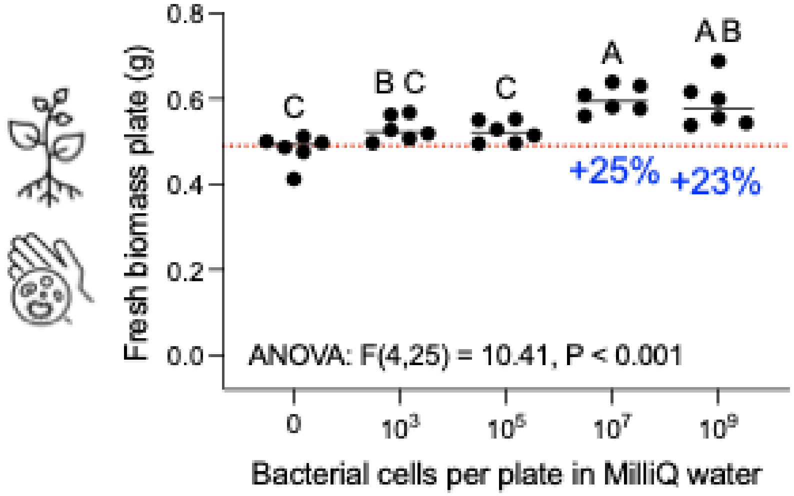
environmental microbiology

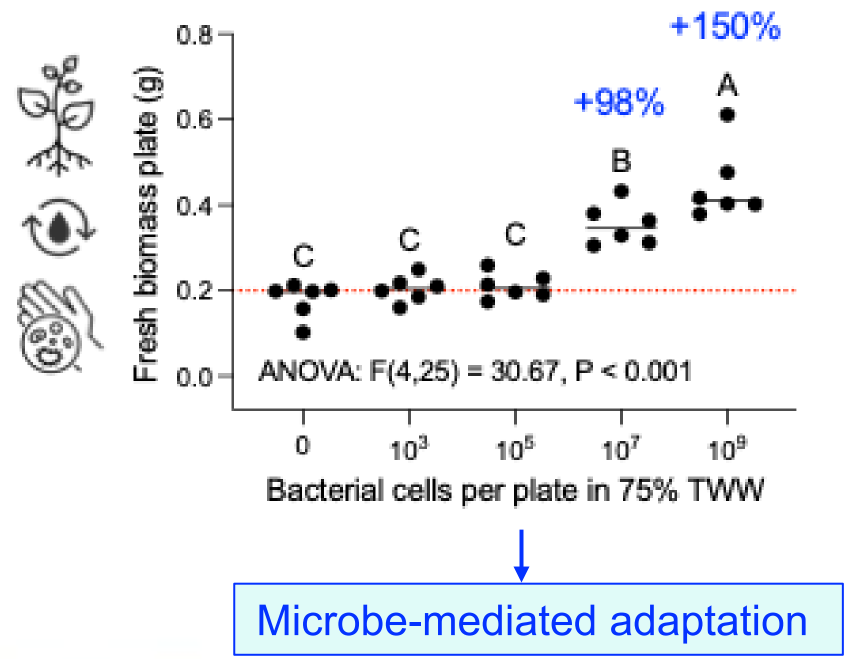
society for applied microbiology

Environmental Microbiology (2015) 17(2), 316–331 doi:10.1111/1462-2920.12439

Improved plant resistance to drought is promoted by the root-associated microbiome as a water stress-dependent trait

Can we overcome such "stress" by treating plants with beneficial bacteria?





What is ongoing?

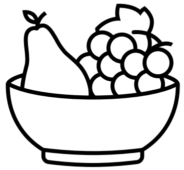
How does KAUST AnMBR-TWW affect early-stage growth (< NH_4^+)?

Use of KAUST AnMBR-TWW post-germination in hydroponic systems

- Can **beneficial bacteria** be implemented in TWW-hydroponic systems at a reasonable cost? Which are their effect on long-term growth?
- Are there any **safety risks** associated with TWW irrigation (e.g., root exudate-fed pathogen, tissue colonization, spread)?





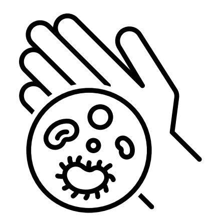


FOOD SECURITY

Use **reclaimed water** to cultivate plants in hydroponic systems or irrigate fields

+

FOOD SAFETY



Ensure the food we eat is **contamination-free**,
i.e., does NOT have pathogens or become a “hot-spot” of AMR

Can (and how) we use the effluent from the AnMBR to grow plants?

Agricultural application: fodder, edible crops (e.g., hydroponic systems for lettuce), and non-food

Land reclamation & Regreening: Saudi Vision 2030, C-offset, improve urban-environment, climate change mitigation

- What are the properties of TWW?
- Can TWW from the AnMBR be used at each stage of plant development (e.g., germination vs post-germ.)?
- Are there any negative inhibitory effects?
- Are there any safety risks (e.g., pathogen spread)?