

1 **Greenhouse gas emissions from rice paddy soils amended with a plant microbial fuel cell.**

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10 Microbial metabolism in a mixed culture anode of microbial fuel cell fed with mixed sources of
11 organic carbon largely resembles the metabolism found in anaerobic environments (digesters,
12 sediments) where CH₄ is the end product instead of electrical current. It is hypothesized that current
13 generation is a viable competitor to steer or control CH₄ emissions from (cultivated) wetlands. It has
14 already been shown that a plant-MFC is capable of efficiently converting organic carbon derived from
15 rhizodeposition into an electrical current. To understand the interaction between methanogenic
16 metabolism and current generation in waterlogged sediments, several microcosm studies have been
17 carried out.

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19 Firstly, it was determined that granular conductive carbon mixed in a 2/3 volume ratio in the sediment
20 yielded the best current production in planted sediment-MFCs. Secondly, microcosms with and
21 without rice plants, that contained various amounts of exogenous organic carbon, were operated
22 with or without external electrical circuit. Current and power production, electrode potentials, N₂O
23 and CH₄ emissions, plant growth, soil organic carbon and microbial community structure were
24 examined.

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26 The results showed that current generating metabolism can compete with methanogenic
27 metabolism when the former has a 'head-start'. Indicating that when the soil contains a low
28 concentration of organic carbon or has recently experienced a period with a high redox potential but
29 the electrical circuit is in place with the correct microorganisms, current generation is able to
30 outcompete biological methanogenesis. However, when interrupting the electrical circuit or supplying
31 an excess of organic carbon, methanogenic metabolism is able to win the competition.

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33 Hydrogen was the most important intermediate as obligate hydrogenotrophic methanogens were
34 abundantly present while mixotrophic or acetotrophic methanogens were hardly detected in the
35 bulk soil or on the electrodes.

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37 Overall, current generation with plant-MFCs is an interesting option to control CH₄ emissions from
38 wetlands but needs to be applied in combination with other strategies.