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

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Microbial metabolism in a mixed culture anode of microbial fuel cell fed with mixed sources of organic carbon largely resembles the metabolism found in anaerobic environments (digesters, sediments) where CH_4 is the end product instead of electrical current. It is hypothesized that current generation is a viable competitor to steer or control CH_4 emissions from (cultivated) wetlands. It has already been shown that a plant-MFC is capable of efficiently converting organic carbon derived from rhizodeposition into an electrical current. To understand the interaction between methanogenic metabolism and current generation in waterlogged sediments, several microcosm studies have been carried out.

Firstly, it was determined that granular conductive carbon mixed in a ⅔ volume ratio in the sediment yielded the best current production in planted sediment-MFCs. Secondly, microcosms with and without rice plants, that contained various amounts of exogeneous organic carbon, were operated with or without external electrical circuit. Current and power production, electrode potentials, N_2O and CH_4 emissions, plant growth, soil organic carbon and microbial community structure were examined.

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

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

Overall, current generation with plant-MFCs is an interesting option to control CH_4 emissions from wetlands but needs to be applied in combination with other strategies.