Universität Rostock

Traditio et Innovatio

# The energy potential of soft rush *(Juncus effusus L.)* for different utilisation pathways

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## Introduction

Rushes are prominent wetland plants of the genus *Juncus* occurring world-wide in a broad range of species. They are well adapted to conditions of waterlogging and often provide crucial eco-system services in natural peat- and wetlands. Tall rushes like *Juncus effusus* tend to dominate the vegetation especially under periodically wet conditions and offer a great biomass potential (Fig. 1). Moreover, using rushes as phytoremediation plants to clean waste water can also lead to high yielding stands. Removing rush biomass is often necessary in wetlands to enhance the ecosystem services for a variety of reasons (removal of nutrients, encourage regrowth, reduction of competition, providing habitats for birds). There is almost no value of rush for livestock feeding and if rush stands need to be harvested, it makes sense to utilise them in different ways: The use for energy purposes seems to be the most promising one.

This study aimed at analysing the use of rush biomass for energy purposes in different utilisations.

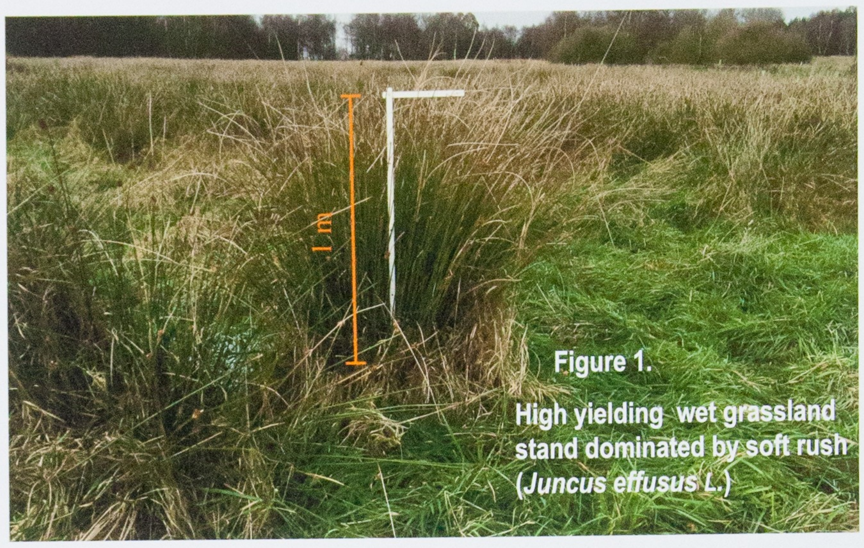


**Figure 1.**
**High yielding wet grassland stand dominated by soft rush (*Juncus effusus L.*)**

## Materials and Methods

We investigated three alternative energy utilisation pathways for rush biomass use and to evaluated their energetic conversation efficiencies: biomethanisation via wet fermentation technique (i), biomethanisation via dry fermentation technique (ii), and combustion (iii). Batch experiments (i), experimental fermenters (ii) and thermocalorimetric equipment (iii) were used to measure energy output per unit rush biomass input (see Fig. 2).

Batch experiments were done according to the technical norm VDI-4630, the heating values were derived from the measured data under the terms of DIN 51900 part 2.

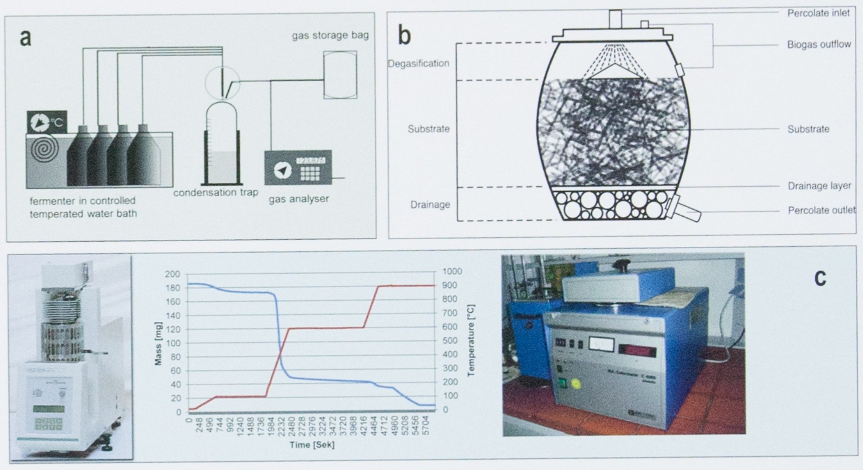


**Figure 2. Scheme of experimental biomethanisation equipment:**
**a)** wet fermentation batch technique (1 l) **b)** dry fermentation batch fermenter (120 l)
c) thermocalorimetric equipment

## Results and Discussion

Wet fermentation technique yielded significant higher in biogas than dry fermentation (399 lN·kg$^{-1}$ oDM compared to 258 lN·kg$^{-1}$ oDM). It corresponds to 59 % (a) respective 43% (b) of the specific biogas potential of the superior (co)substrate whole crop maize silage as a reference (Fig. 3).

Nevertheless, low cost prices for substrate production makes *Juncus effusus* appropriate for energetic utilisation, provided that low field – plant - distances can be realised.

There is a great potential to improve conversation technique in the dry fermentation pathway while the technical potentials of the other conversion pathways are more exhausted.

From the point of conversion efficiency, combustions seems to be the preferred way but is limited by technological aspects of biomass flow-rate (Tab. 1).

**Table 1. Efficiency of the different conversion pathways to utilise soft rush**

| Substrate | Conversion technique | Biomass yield (t DM * ha$^{-1}$) | Brutto energy yield (kWh * ha$^{-1}$) | Converted thermal Energy (kWh * ha$^{-1}$) | Electricity fed into the grid (kWh * ha$^{-1}$) | Conversion Efficiency | Area demand (ha) |
|---|---|---|---|---|---|---|---|
| Silage maize | Wet fermentation | 20 | 101.278 | 26.259 | 23.205 | 48% | 19 |
| Soft rush / grass | Wet fermentation | 12 | 57.336 | 20.578 | 18.185 | 67% | 24 |
| Soft rush / grass | Dry fermentation | 12 | 57.336 | 11.961 | 10.570 | 39% | 42 |
| Soft rush | combustion | 3,5 | 18.225 | 15.136 | not applicable | 83% | 127 |

**This investigation shows that the energy conversion of soft rush by biomethanisation is more advantageous than the combustion pathway. Preferably the biomass should be used as a co-substrate in a wet-fermentation biogas plant to substitute silage maize in proportions lower than 30%. The determined gas and energy yields of the dry-fermentation variations are exceptional very low. A malfunction of the test facility is more probable than the biomass or the dry-fermentation system in general. The high energetic conversion efficiency of the combustion system can´t balance the low full load time.**

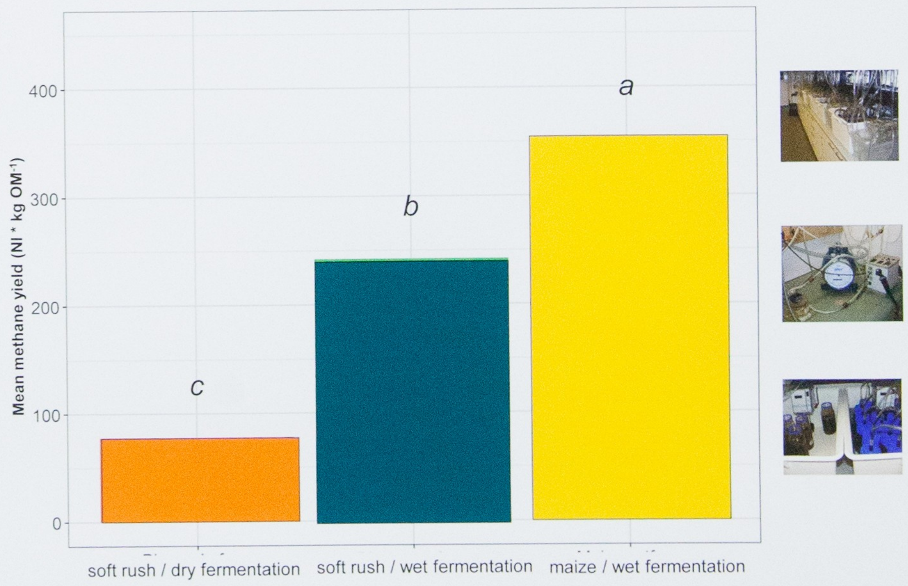


Figure 3. Mean methane yield (Nl * kg OM$^{-1}$) of different fermented soft rush compared with maize as a reference co-substrate
(different letters indicate significant differences of the means, post hoc Tukeys HSD, p<0.05 )

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