Integrating the bioenergy production with biodiversity conservation on semi-natural and riparian grasslands

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Introduction

Semi-natural grasslands in Poland have been identified as having extraordinary biodiversity value. In the past, the species richness of these semi-natural landscapes has been managed through grazing. However, livestock numbers are now in decline, many grasslands are abandoned and consequently the diversity of these landscapes is under threat. In order to prevent these habitats from turning to scrublands, these areas have to be extensively harvested. Regulations dictate a late harvest time to allow reproduction of the flora and fauna. Many of semi-natural and riparian grasslands are protected under the European Habitats Directive and their management is financially supported by introduction of agri-environmental schemes (Goliński and Golińska 2011). The biomass harvested from those grasslands is not suitable in animal feeding but can be used for bioenergy production (Wachendorf and Soussana 2012).

The aim of this study was to analyse the possibilities of integrating the bioenergy production with biodiversity conservation of semi-natural and riparian grasslands in Wielkopolska region.

Methods

The study was carried out in 2012 in Wielkopolska province, which is one of the largest regions in Poland. Permanent grasslands are mostly concentrated in river valleys. We focused on two areas – the valleys of the Barycz and Noteć rivers. These areas contain high-value semi-natural and riparian grasslands that are included in the European network Natura 2000 as areas of special bird and habitat protection. Many farmers managing these grasslands are looking to diversify their activities. Agri-environmental programmes have been established that are focused on protection of endangered bird species, habitats and natural sites within and outside the Natura 2000 areas (Goliński 2012). Farmers receive financial support for fulfilment of special management of these grasslands. One of the main conditions is late harvest time – typically in the middle of July or beginning of August. Because the harvested biomass can be used for bioenergy purposes, we evaluated the quantity and quality of the biomass from selected grasslands. The botanical composition and yield of harvested biomass from 20 meadows located in both valleys was estimated and samples of biomass for chemical analyses were collected. In the samples the crude protein (XP), NDF, ADF and ash (XA) using commonly accepted methods were determined. In the representative samples from each valley after ensiling the biogas and methane yields using analysers of Geotechnical Instruments Co. and Varian MicroGC-4900 were evaluated.

Results

Lower DM yield was measured in the Noteć valley (Table 1), where the *Phalaridetum arundinaceae* association was dominant. In terms of botanical composition, this association is characterized by high proportions of *Phalaris arundinacea, Phragmites australis* and *Carex* species. In the Barycz valley, the semi-natural grasslands were mainly represented by *Arrhenatherion* alliance. The multi-species sward of this alliance was dominated by grasses: *Arrhenatherum elatius, Dactylis glomerata, Festuca rubra, Holcus lanatus, Phleum pratense, Poa pratensis* with high share of dicotyledonous species like *Achillea millefolium, Galium mollugo, Heracleum sphondylium, Lotus corniculatus, Plantago lanceolata, Rumex thyrsiflorus, Trifolium pratense*.

Lower potential of DM yield of Noteć grasslands was correlated with lower quality of harvested biomass. The mean content of XP in collected samples reached 84.6 g/kg DM for Noteć valley that was 20% lower than for Barycz valley. A similar level of XA in biomass from both sites was determined. The Noteć grasslands, in comparison to Barycz, showed higher NDF and ADF contents, 563.1 and 367.0 g/kg DM, respectively. Due to high concentrations of structural carbohydrates, the typical utilization of biomass from this grassland for bioenergy production is combustion. Another possibility is conversion into biogas – technology that has been rapidly developing in Poland in recent years. One of the most important potential sources of substrate for biogas plants is biomass collected from semi-natural and riparian grasslands, especially from Natura 2000 sites. This kind of substrate is not competitive with maize, which is the most popular crop for biogas production but is often eco-inefficient, *e.g.* due to the increased risk of soil erosion and nutrient losses and causes ethical and socio-economic problems (Wachendorf and Soussana 2012). In our study, the yields of biogas and methane after ensiling of harvested biomass from grasslands of Noteć valley were lower in comparison to Barycz valley (Table 1).

Table 1. Characteristics of biomass from semi-natural grasslands in two locations of Wielkopolska region.

Quantitative and qualitative parameters	Unit	Valley of Barycz River		Valley of Noteć River	
		Mean	Range	Mean	Range
DM yield	t/ha	5.7	3.5-9.0	5.4	4.0-7.0
DM content in cut biomass	% of FM	30.8	21.6-43.1	36.4	30.2-39.1
Crude protein (XP)	g/kg DM	103.5	67.5-180.0	84.6	65.0-102.5
Neutral detergent fibre (NDF)	g/kg DM	509.8	459.1-582.6	563.1	510.1-592.0
Acid detergent fibre (ADF)	g/kg DM	316.1	278.6-350.6	367.0	301.5-396.6
Ash (XA)	g/kg DM	63.6	52.0-	64.5	49.5-83.5
Biogas yield	L_N/kg oDM	500	-	267	-
Methane yield	L CH_4/kg oDM	338	-	184	-

The results showed that the biogas and methane yields from semi-natural and riparian grasslands are in general lower than standard substrates like maize. A new challenge is to improve the conversion efficiency of semi-natural grassland biomass into bioenergy. A solution to this matter is introduction of the Integrated Generation of Solid Fuel and Biogas from Biomass (IFBB) system (Wachendorf *et al*. 2009) in Poland. This technology is especially adapted to fibre-rich materials. The IFBB technique aims at dividing the grassland silage into a solid part for combustion and a liquid fraction for biogas production. The extraction of minerals and easily digestible compounds into the liquid significantly improves the combustion performance of the fuel and makes a press fluid which can be used as a substrate for biogas production.

Conclusion

Semi-natural and riparian grasslands in Wielkopolska region are high nature value areas, mainly in terms of biodiversity. In the Barycz and Noteć valleys the grasslands are mostly covered by Natura 2000 network and included in agri-environmental schemes. Because of late cutting, the harvested biomass is fibre-rich and can be used for bioenergy production. The IFBB technology helps to improve the process of bioenergy conversion from semi-natural and riparian grassland biomass.

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