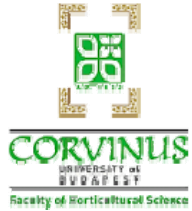




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BIOMASS OF TALL FESCUE AS RAW MATERIAL FOR BIOGAS PRODUCTION

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Introduction

Biogas production is becoming the most popular source for bioenergy in small farms, food factories and waste water treatment. The anaerobic digestion of energy crops and agricultural residues can contribute considerably to national energy balances (Plöchl, Heiermann, 2006; Holm-Nielsen, Olieskewicz-Popiel, Al Seadi, 2007).

The biogas production is influenced by many parameters which are related to the process conditions, substrates and the concentrations of nitrogen, carbon, lignin, cellulose, hemicellulose, sugars, proteins in them (Gerin et al., 2008; Janušauskas, 2003; Raclavská, Juchelková, Roubíček, 2007).

The selection of appropriate plant species as feedstock for biogas production is an important aspect in decision-making. Biogas crops should have characteristics like high yields and low production inputs (Heiermann et al., 2009).





which herbaceous plants to choose ?

Traditional

Alternative



Festuca arundinacea



Dactylis glomerata



Silphium perfoliatum



Miscanthus



Artemisia



Sida hermaphrodita

Perennial grasses or grassland could be promising plants for non-food purposes
???





Utilization of pure *Phalaroides arundinacea* L., *Bromus inermis* Leysser, *Melilotus officinalis* (L.) Lam., *Lupinus polyphyllus*, *Galega orientalis* Lam. and grass/legume mixtures for biogas was estimated and investigations showed, that

1 kg DM of herbage - 0.531 – 0.678 m³ biogas, which contains 64.5-72.8 % of methane

(Navickas et al., 2003)

Dry matter yield of fodder grass swards can reach 6 – 13 t ha⁻¹ in leys and 6 – 7 t ha⁻¹ DM in pastures depending on management (Brenciene, 1995; Daugeliene, 2002; Kadziuliene, Kadziulis, 2007; Jasinskas, Zaltauskas, Kryzeviciene, 2008).

Methane yields of grassland biomass vary in a wide range, mainly depending on the intensity of grassland use. An intensive management with an early first cut and several cuts per year leads to both high substrate-specific and area-specific methane yields and vice versa (Prochnow et al., 2008).



Lithuania

Total land area,
thousands ha

6530.0

Land for agriculture

3365.0:

Arable land **2873.0**

Crop area **1750.0**

Perennial grasses

416.1

Perennial grassland

573.9

Meadows and natural

pastures **448.5**



Forecasting energy crops on 22 % or 740 thousand ha of the total agricultural land: 42% for biofuels
52% for biomass.

Grasses on 129 thousand ha (Šateikis, 2006)



The use of grassland for energy is one of potential renewable resources and good possibility of promoting multifunctional, sustainable agricultural sector.

Grassland has a number of positive effects on the environment and biodiversity.



BIOMASS OF TALL FESCUE AS RAW MATERIAL FOR BIOGAS

Project Plant Biomass Value Enhancement by Biotechnology Methods

The study is supported by the Lithuanian State Science and Studies Foundation

One of the tasks of the project is

Enhancement of valuable products biomass productivity and quality by agrotechnological implements making qualitative biomass composition which have influence for biogas parameters and methane yields

A few experiments is ongoing.....



The aim of the present study was to estimate the chemical composition of tall fescue biomass grown for biogas production in relation to the timing of the first cut and mineral nitrogen fertilization.



Materials and methods

Field and laboratory experiments were carried out at the Lithuanian Institute of Agriculture in Dotnuva (55° 24'N) in 2008.

The soil of the experimental site is characterised as *Apicalcari - Endohypogleyic Cambisol, light loam*.

Tall fescue (*Festuca arundinacea* Schreb.) swards in the second year of use.

Tall fescue swards were grown without fertilizers and with mineral nitrogen applied at a rate of 150 kg ha⁻¹ in spring at the beginning of vegetation.

The swards were cut twice per season (on the dry weather conditions). The first cut was taken at different growth stages - heading or flowering.





Materials and methods

The total nitrogen and organic carbon were determined using the Dumas method (DIN/ ISO 13878)

Crude protein was calculated $N \times 6,25$

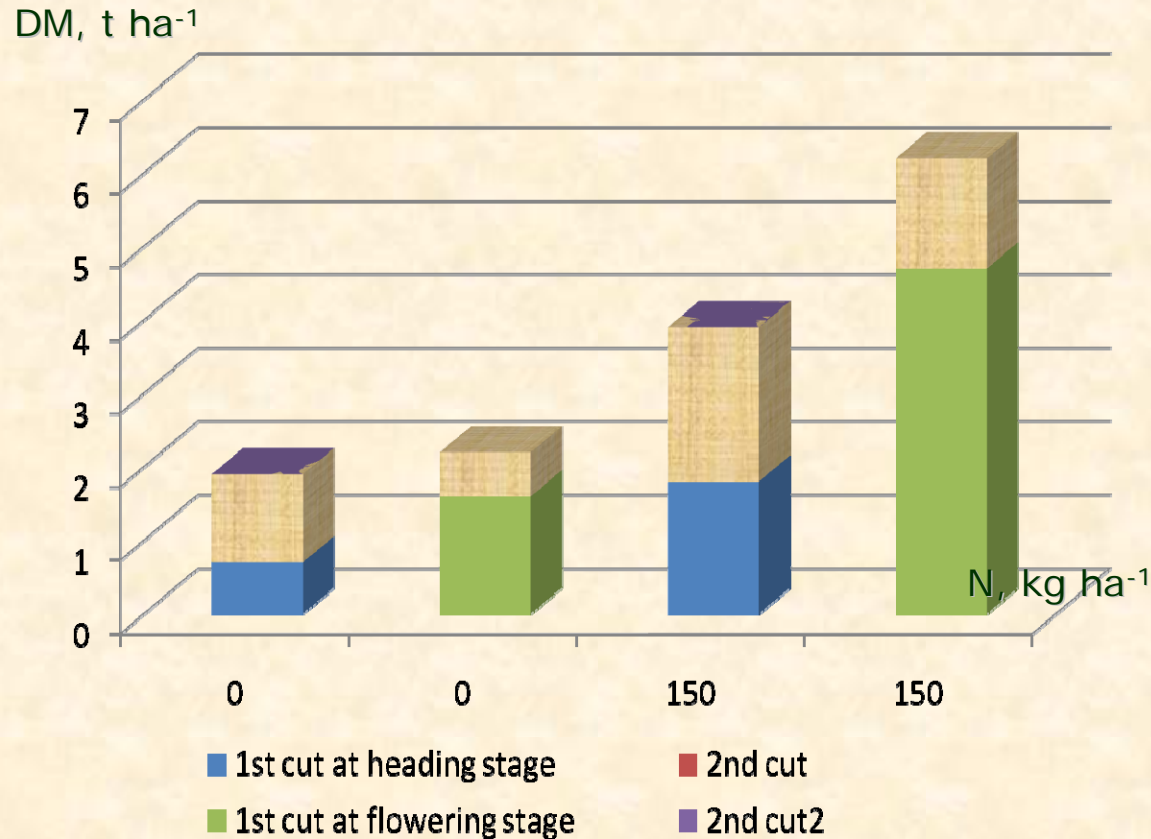
Acid detergent fibre (ADF), neutral detergent fibre (NDF), and lignin (ADL) were estimated using the van Soest methodology of fibre fraction

The quantities of cellulose, hemicellulose were calculated:
cellulose = ADF-ADL, hemicellulose = NDF-ADF (Faithfull, 2002).





Results and discussions



Tall fescue, DM t ha⁻¹ year⁻¹

12.1 (1st cut at beginning of heading -3.6)

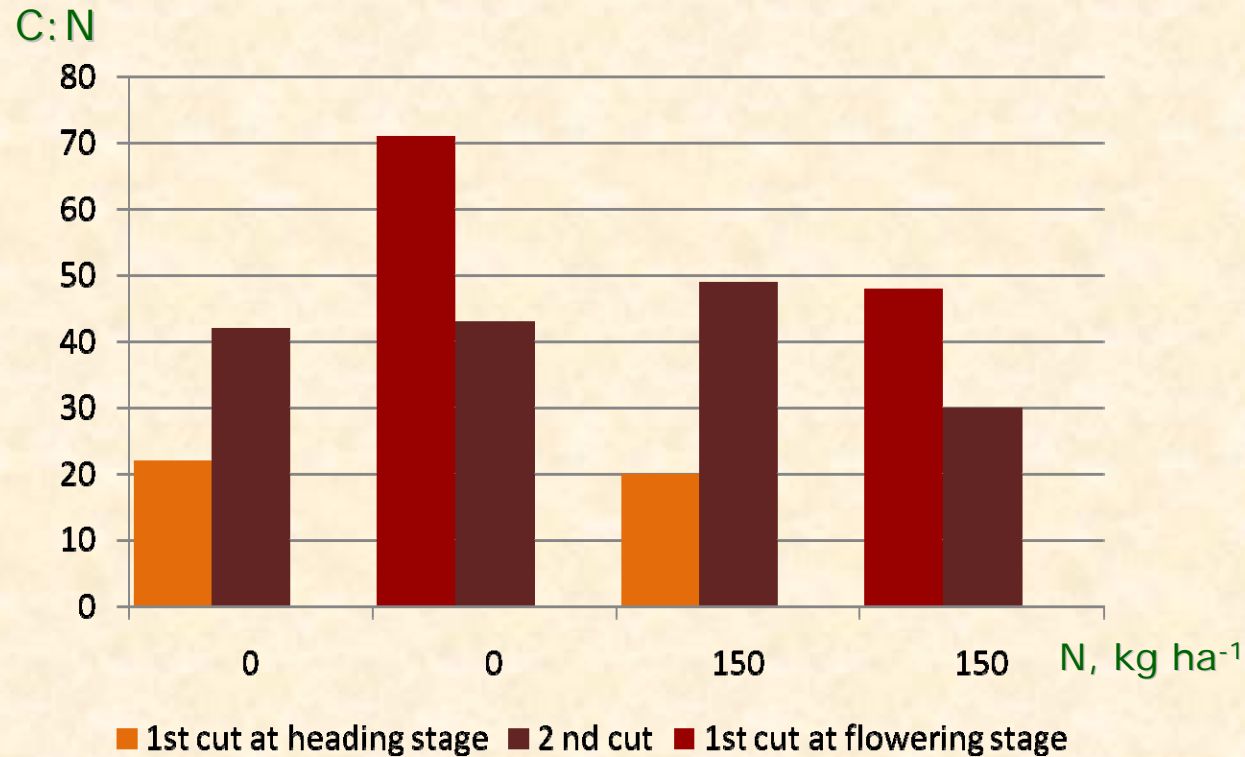
13.1 (1st cut at heading - 4.9)

13.6 (1st cut at heading - 6.0),

but 3 cuts, N 240 kg ha⁻¹
(Brenciene, 1995)

Biomass yield at heading and flowering stages





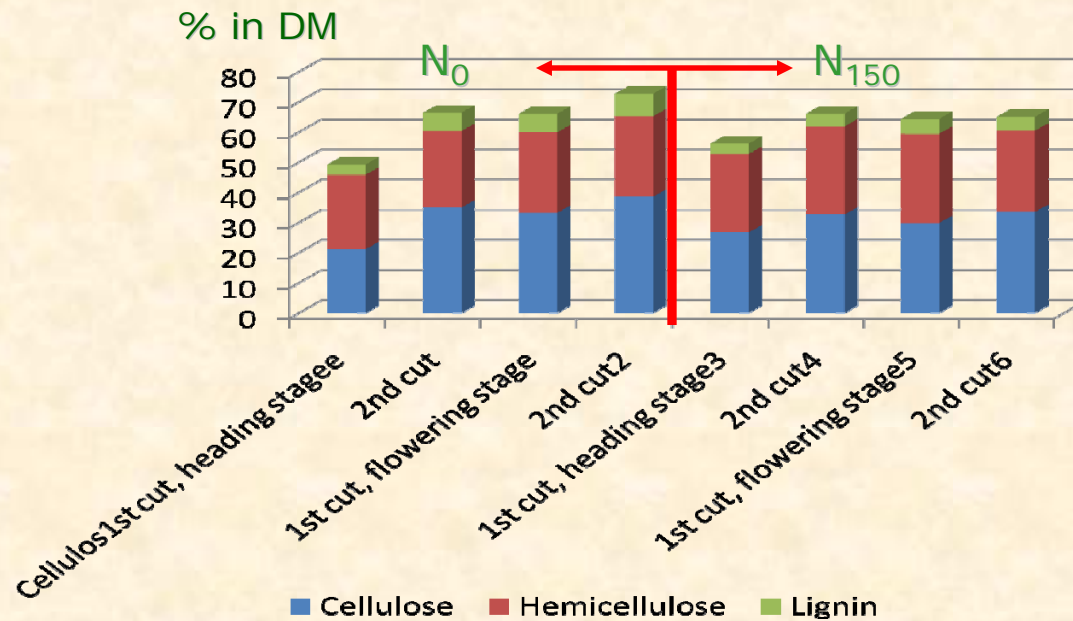
The carbon and nitrogen ratio in the biomass for anaerobic digestion is optimum 20 – 30 (Dennis, Burke, 2001)

Most suitable carbon to nitrogen ratio for biogas production was in fertilized and not fertilized tall fescue biomass cut at heading stage

The influence of grass vegetation period on carbon to nitrogen ratio was higher than that of nitrogen fertilization.

The variation of carbon to nitrogen ratio in tall fescue biomass at heading and flowering stages





There were no significant differences in the concentration of hemicellulose and cellulose in the biomass of fertilized and not fertilized tall fescue cut at heading and flowering stages.

The variation of the ratio of structural biopolymers in the fibre of the biomass at heading and flowering stages





The variation of elements in tall fescue biomass at heading and flowering stages

Cutting time	Indicators g kg ⁻¹ DM						
	P	K	S	Ca	Mg	Crude protein	WSC
Tall fescue N₀							
1 st cut, at heading	2,62	23,2	1,99	4,31	0,81	123,0	237
2 nd cut	3,89	14,3	2,30	8,63	1,52	64,4	145
1 st cut, at flowering	1,86	13,6	1,68	2,55	0,64	38,5	171
2 nd cut	2,46	12,4	1,56	6,70	1,37	63,8	108
Tall fescue N₁₅₀							
1 st cut, at heading	2,70	21,6	2,14	4,31	1,07	141,0	159
2 nd cut	2,84	14,8	1,63	6,68	1,14	56,3	110
1 st cut, at flowering	1,67	18,6	1,73	3,34	0,68	58,1	160
2 nd cut	3,76	15,0	2,72	11,0	1,73	92,5	148

The biomass contained more than three times higher yield of crude proteins at heading stage compared to biomass cut at flowering stage

There were found little differences in the concentration of macro elements in the biomass of fertilized and not fertilized with nitrogen swards cut at heading stage.

At flowering stage, the concentration of macro elements in the biomass of fertilized grass, except phosphorus, was higher compared to the biomass, cut at heading stage.





Conclusions

The annual biomass yield was higher in fertilized sward compared to non fertilized and the biggest biomass yield was when the first cut was made at flowering stage.

The biomass of tall fescue at the heading stage is better suited for biogas production, since it contains less lignin and more water-soluble carbohydrates in dry matter and a more adequate carbon-to-nitrogen ratio.





**Thank you
for your
attention !**



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