The newsletter for biogas generation – by Schaumann BioEnergy

BioEnergy News

Successful silaging of forage rye for use in biogas plants

With the aim of optimizing biomass yields this year, last year's unique climatic conditions required a large number of sites to focus their crop rotation on grain and an early harvest of forage rye.

All grain types possess a basic suitability for whole crop harvest, silaging and their use as feedstock in biogas plants. The ultimate choice of grain type and variety is based primarily on location specific criteria, e.g. precipitation rate, moisture retention and soil quality. In sites showing sufficient precipitation rates between May and July, double-cropping systems have proved successful, such as green winter rye (first crop) followed by maize, sudan grass or sorghum as second crop.

The following paragraphs summarize a range of useful suggestions starting from optimal time of harvest via crop processing to ensiling.

Harvesting green forage rye requires attention to a number of crucial characteristics having lead in the past to a wide range of varying recommendations regarding optimal preservation and the use of silage additives. For a crop as challenging as green rye and when looking at different cultivation sites and varying fertilization strategies, two contrary recommendations regarding silage additive application can be correct!

Green rye – harvest during ear emergence

During crop rotation with maize, rye as winter catch crop is the sole grain variety offering high mass yields by mid to end May, thereby still offering acceptable seeding dates for maize, sudan grass or sorghum.

For this purpose, fast-growing rye varieties are used which provide benefits regarding dry matter content as well as general biomass even at early harvest dates. Targeted plant breeding has yielded rye varieties thriving in the low temperature range, thus being superior to common varieties adapted to higher temperatures.

The optimal time of harvest lies at the start of ear emergence (ear tangible, awns not yet visible; BBCH stage 49-51). Generally, stock will be at ca. 65-75 cm at that point. If the crop is put in a swath directly after cutting, field retention time of 24 to max. 48 hours should not be exceeded. Cutting height is recommended to be at least 7 cm.

A guideline for a minimum dry matter content for silaging can be calculated as a function of sugar content (S) and buffering capacity (BC) using the following equation:

$$DM_{min} = 45\text{-}8\ S/BC$$

Minimum dry matter content in green rye as a function of S/BC:

S/BC	Minimum DM %
1.8	31
2.2	27
2.4	26
2.6	24
2.8	23
3.1	21

In green rye, buffering capacity may vary within a range of 45 and 56 g LA/kg DM (LA: lactic acid). Longtime average of sugar contents (S) lies at ca. 135 g/kg DM (variation 90–165 g/kg DM).

DM ought to lie above 21 %, crude fibre below 260 g/kg DM. The use of biological silage additives cannot be recommended at dry matter contents below 20 %!

Particular attention needs to be paid to minimizing a crop's soil contamination dur-

ing harvest. This particularly applies when the crop is first spread and then put in a swath for wilting.

The recommended theoretical chop length lies between 35 and 45 mm.

Due to its comparatively low DM content and overall composition, green rye is vulnerable to proliferation of undesirable anaerobic bacteria (Clostridia). This poses a high risk of accumulation of butyric acid, biogenic amines and ammonia due to uncontrolled degradation processes, causing high energy losses and spoilage upon clamp opening.

At a cell division speed of 0.5 h, the following numbers of Clostridia can originate from only one cell:

- In 1 h: 4 Clostridia
- In 5 hrs: 1,024 Clostridia
- In 10 hrs: 1,048,576 Clostridia

These facts illustrate that the application of specifically tailored silage inoculants is imperative! Only exact application of a silage additive fitting each individual case while following optimal clamp management procedure will meet the challenges posed by green rye as a crop.

Fig. 1: Development of silaging losses in green rye with and without SILASIL ENERGY.BG (ISF, 2015)

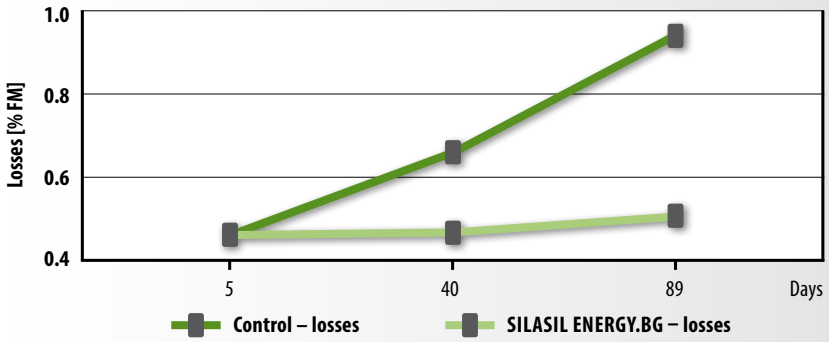

Fig. 2: Digestion parameters and BMP-test results from green rye silages with and without SILASIL ENERGY.BG (ISF, 2015)

	DM	Control	SILASIL ENERGY.BG
Silage Parameter			
$DM_{corr.}$	% FM	0.0	0.0
Lactic acid		1.5	2.0
Acetic acid		0.9	0.8
Butyric acid		0.0	0.0
pH-value		4.1	3.9
Methane potential			
Silage	IN / kg $oDM_{corr.}$	373	386
Silage	%	**100**	**103**
Methane proportion	%	52	53

- The naturally occurring presence of lactic acid bacteria (LAB) is comparatively low on green rye, i.e. pH-decrease during initial silaging stage is slow.
- The presence of Clostridia varies greatly due to soil type and fertilizing management, i.e. high Clostridia counts often lead to spoilage.
- The mean digestibility coefficient (DC = 35) indicates a crop characterized by low digestibility, i.e. long retention times required for full degradation.
- The S/BC quotient depends to a high degree on the stock's N-fertilization, i.e. increasing fertilizing intensity leads to decreasing sugar contents!

Fertilization intensity	DM	Sugar	Buffering capacity	S/BC	Digestibility coefficient
	g/kg	g/kg DM	g MS/kg DM		
75 kg N/ha	170	140	45	3.1	42
100 kg N/ha	160	130	50	2.6	37
150 kg N/ha	150	100	56	1.8	29

These circumstances further highlight the importance of accurately taking all underlying conditions into consideration to make the right choice in silage additives for your crop's specific requirements.

As a general rule, for the preservation of green rye, homofermentative silage inoculants with specific effect against Clostridia provide the best fit. SILASIL ENERGY.BG has been designed to most effectively counteract the effects of high clostridial counts. It is optimized for the sole use in clamps for use as feedstock in biogas plants. SILASIL ENERGY.G shows the same properties but has the double advantage of being licensed for use in biogas as well as feed for animal husbandry.

The application of heterofermentative LAB – SILASIL ENERGY.XD and SILASIL ENERGY.C- can only be recommended as an exception, i.e. when wilting occurred before harvest, after minimum N-fertilizer application, minimum contamination/ crude ash-intake, when DM >32 %.

Field trials conducted by ISF Schaumann Research in Wahlstedt, Germany, where green rye treated with SILASIL ENERGY. BG was compared to untreated crop, showed distinctive benefits in the treated variant: changed acid speciation after rapid pH reduction, protection from clostridial proliferation, reduced losses (see fig. 1) and an increase in methane yield by 3 % (see fig. 2).

To protect shoulder and top areas of clamps particularly at risk of spoilage, application of 200 g/m² of the granulated product SILOSTAR PROTECT, or application of BC.ACID1 (1 litre product + 3 litres water/m²) has proven very successful.

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