LANDWIRTSCHAFTLICHES ZENTRUM
für Rinderhaltung, Grünlandwirtschaft, Milchwirtschaft, Wild und Fischerei Baden-Württemberg (LAZBW)
Atzenberger Weg 99, 88326 Aulendorf

Density, silage temperature and fermentation quality of sudan grass
Project PistenBully 2009

1.Test question

How are the compaction, silage temperature and fermentation quality of Sudan grass silage affected by use of a snow groomer as the spreading and rolling vehicle?

2. Material and methods

2.1 Silage crop:

Sudan grass was cultivated by Dertinger in 2008 and was ensilaged by subcontractor Kogel in calendar week 42 using a chaff chopper and was exclusively spread and compacted with a snow groomer (PistenBully 300). The LAZBW (Baden-Württemberg agricultural centre for ruminant production, grassland management, dairy management, wildlife and fisheries) was not represented or involved in the harvest or ensilaging. According to figures from Mr Dertinger (weighing logs available) 1,931 t harvested crop (fresh mass) were unloaded in 20.8 hours. This results in a mean output of 92.8 t FM per hour.

2.2 Firm:
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2.4 Silo type:
Bunker silo with fixed side walls, covered with tarpaulin
3 m wall height,
80 m length, of which approx. 50 m filled
20 m silo width

The silo fill level measurements taken before removal on 19th November 2008 by Kässbohrer (Mr Magg and Mr Weiler) are available.

2.5 Local sampling dates:

1. **D1** 19th January 2009 approx. 2 m filled (approx 9-10 m from the front from the start)
2. **D2** 7th March 2009 with full fill height of approx. 3 m and approx. 30 m from the front
3. **D3** 18th April 2009 with full fill height of approx. 3 m and approx. 45 m from the front

2.6 Sampling position:

1. **P1** on the left-hand side approx. 0.30-0.50 m from the side wall (**edge 1**)
2. **P2** on the left-hand side approx. 0.70-1.00 m from the side wall (**edge 2**)
3. **P3** in the middle of the silage pile, 10 m from the right-hand wall **(middle)**

On the first date, the samples were removed 0.30 m (edge 1) and 0.70 m (edge 2) from the side wall, and 0.50 m (edge 1) and 1.00 m (edge 2) from the side wall on the later dates.

2.7 Layers:

1. **L1** approx. 0.30 m from the access edge starting from the top
2. **L2** approx. 1.00 m from the access edge starting from the top
3. **L3** approx. 0.50 m above the silo floor

2.8 Analyses:

1. 1. Density using Pioneer borer in kg FM/m³ and kg DM/m³
2. DM content in g DM/kg FM using drying at 105 °C
3. pH values using rapid determination on-site (indicator paper Macherey & Nagel, no. 095300)
4. Sensory evaluation of the silage

Values always mean values of the 3 measurements.

2.9 Process

Once two thirds of the full wall height was reached at the silage access, the sudan grass silage was removed and weighed on three dates (start of removal, silage half removed, end of removal) at three positions (P1 to P3) and three layers (L1 to L3) using a borer (3 bore holes per position and layer) core samples (Pioneer, diameter 4.5 cm, 45 cm long) (Figure 1). Mixed samples were created from the three core samples from the individual positions and layers. The mixed samples were tested immediately using sensory analysis for faulty fermentation and using indicator paper for the pH value. The samples were then weighed (500 g fresh material in crisp packs) to determine the dry substance content (Mettler PM 54). The samples were transported to Aulendorf in a cool box and then dried for at least 24 hours at 105 °C in the drying cupboard to a constant weight.

The temperature was measured using two temperature probes (Testo) at three depths (15 cm, 50 cm, 150 cm from the front edge of the bore hole) in each bore hole (Figure 2).

The ambient temperature was 2.8°C on 19th January 2009, 5.2°C on 7th March 2009 and 7.5°C on 18th April 2009.

There was rain on all the sampling dates. However, the silo access was freshly made by the cultivator just before sampling in each case, so that rain could not affect the samples.

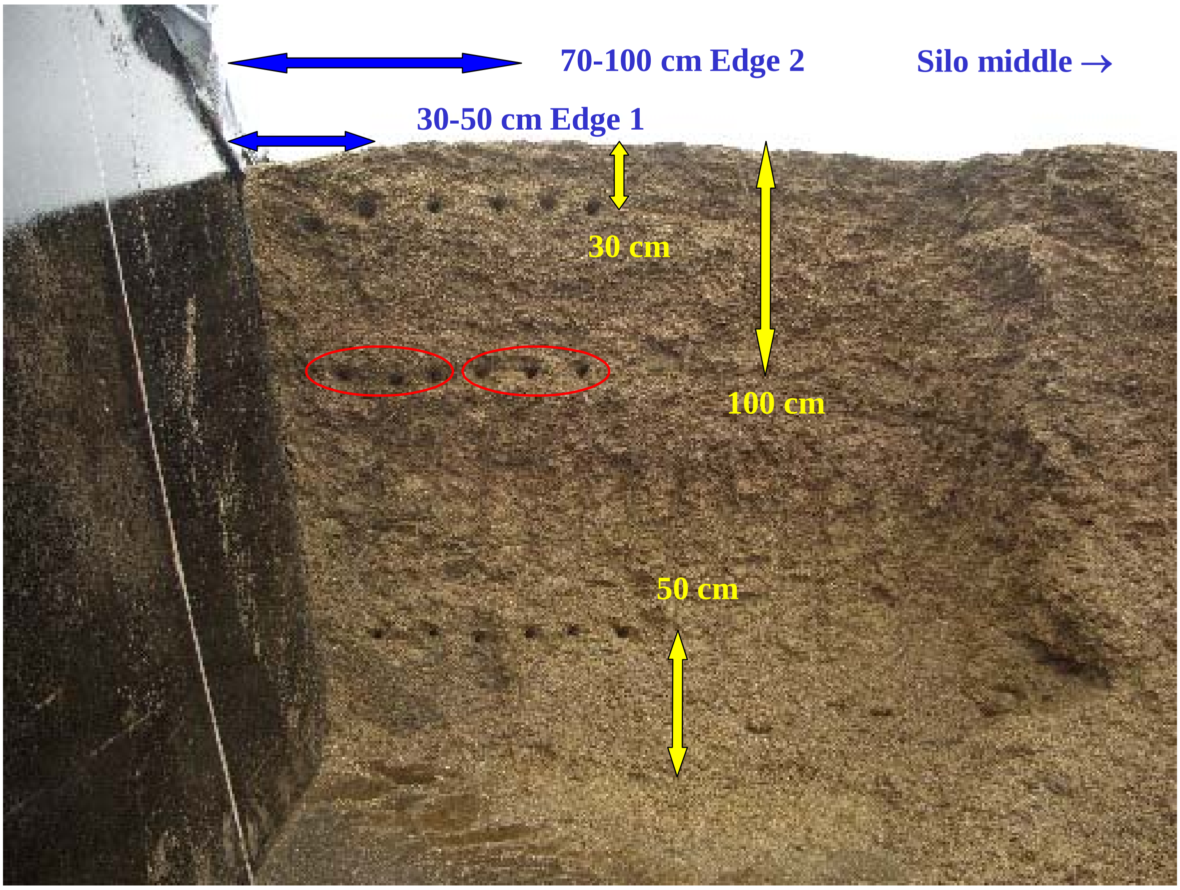

Figure 1: Arrangement of the core samples at the edge of the Sudan grass silage

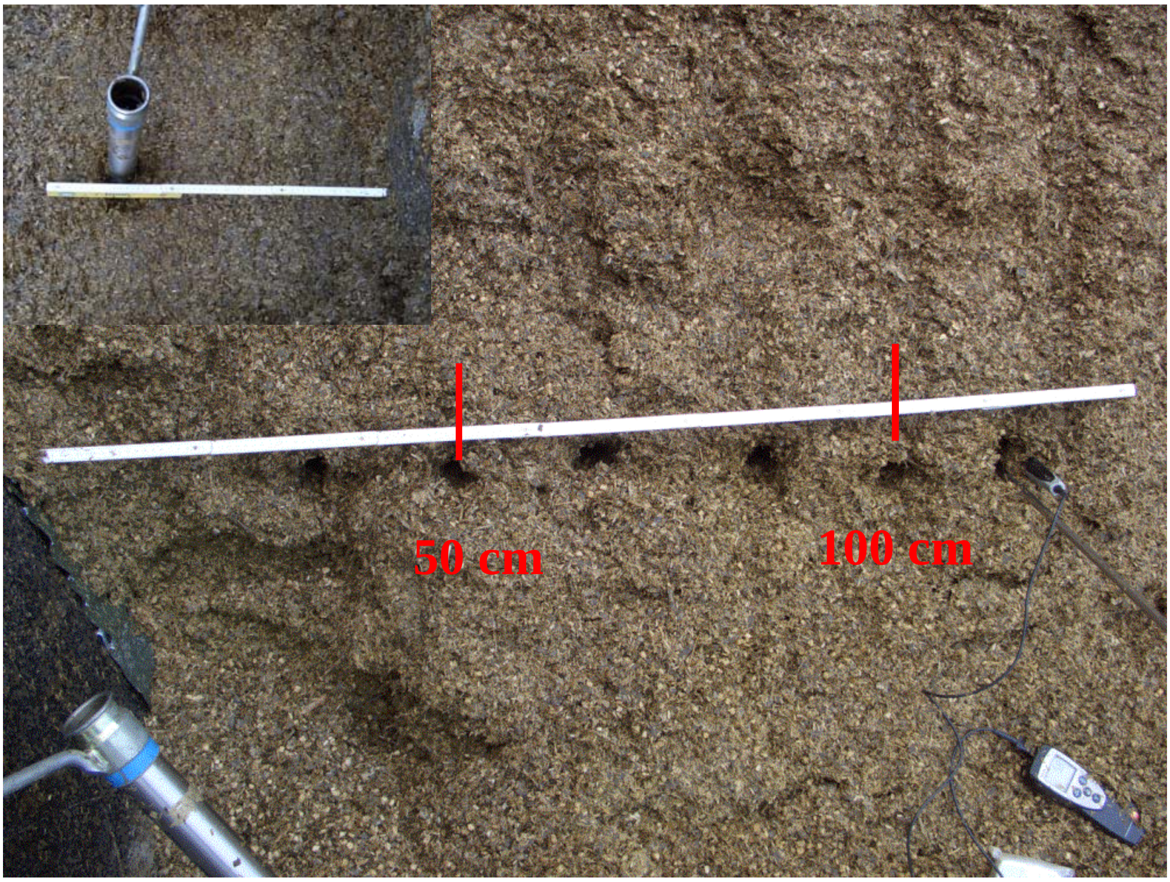

Figure 2: Temperature measurements in the bore holes

3. Results

3.1 DM content

The Sudan grass silage had a mean 16.3 % DM with a spread of 11.4 % DM to 19.5 % DM (Table 4). The lowest content (mean value 15.1 % DM) was recorded in edge section 1, right next to the silo wall, as well as three measured values with less than 14 % DM (Table 2). Some rainwater probably seeped into this area, although the silage was very carefully covered with tarpaulin and undersheet. The fact that the tarpaulins were butted up against the wall certainly contributed to this. It was not possible to pull the tarpaulins over the silo wall because of the type of construction.

Almost the same DM content was recorded in wall 2 section, around one metre from the silo wall, and in the silo middle with a mean 17.0 % DM and 16.9 % DM (Table 2). The spreads here were also comparable with 14.7 to 19.5 % DM (edge 2) and 14.8 to 18.1 % DM (mean).

The DM content in the silo reduced from a mean 17.5 % DM at the top to 16.3 % DM to a mean 15.2 % DM at the bottom (Table 3). This is due to the discharge of fermentation liquid and displacement of the moisture.

3.2 Density

The mean density was 424.5 kg FM/m³ and 68.7 kg DM/m³. The spread ranged from 287.8 to 537.0 kg FM/m³ and from 46.0 to 90.1 kg DM/m³. In terms of fresh mass, the differences between edge 1 (419 kg FM/m³) and edge 2 (411 kg FM/m³) were only slight (Table 2). As expected, the highest compaction was recorded in the middle of the silo at a mean 443 kg FM/m³. In terms of dry mass, which increased from the outside in, the compaction increased from 62 kg DM/m³ (edge 1) to 69 kg DM/m³ (edge 2) to 74 kg DM/m³ in the silo middle. Accordingly, the edge area had around 16 % (edge 1) and 6 % (edge 2) less compaction than the silo middle. The sections up to 50 cm from the silo wall, in particular, are less well compacted.

The compaction in the silo increased from 350 kg FM/m³ to 446 kg FM/m³ to 478 kg FM/m³ (Table 3). In terms of dry mass, layer 2 (100 cm from the top) and layer 3 (50 cm above silo floor) were the same with 73 kg DM/m³ each, because the DM content decreased from the top downward. With 61 kg DM/m³, the uppermost layer had 16 % less compaction than the two other layers. Thus, there was no difference between the edge section (edge 1) with 62 kg DM/m³ and the uppermost layer (30 cm from the top) with 61 kg DM/m³.

Densities of over 200 to 220 kg DM/m³ were achieved in the well compacted grass and maize silage. These values were never achieved in the Sudan grass and were only around a third of the compaction desired for grass and maize silage. In contrast to poorly compacted grass and maize silage, in which the pores in the silage are filled with air and, thus, oxygen gets into the feed on removal, the pores in the Sudan grass silage were mainly filled with water because of the low DM content. As a result, this situation needs to be assessed differently to typical grass and maize silage. Unfortunately, it was not possible to identify comparative values for Sudan grass silage from literature or from other colleagues in Germany.

Table 1: Test results, arranged by the sampling date

Date	Position	Location of the sample	DMc %	Density mean values kg FM/m^3	Density mean values kg DM/m^3	pH	Temperature °C at measured depth 15 cm	Temperature °C at measured depth 50 cm	Temperature °C at measured depth 150 cm
19.01.	Edge 1	30 cm from the top	18.0	299.5	53.8	4.4	-0.8	3.2	4.8
	Edge 1	100 cm from the top	14.9	455.5	67.7	4.3	2.2	5.0	5.0
	Edge 1	50 cm from the bottom	14.3	439.2	62.7	4.4	3.5	5.2	5.3
	Edge 2	30 cm from the top	18.3	287.8	52.5	4.3	-0.1	5.8	5.5
	Edge 2	100 cm from the top	16.8	408.9	68.9	4.4	5.6	7.8	7.3
	Edge 2	50 cm from the bottom	16.8	461.1	77.6	4.4	6.6	7.6	4.8
	Middle	30 cm from the top	17.4	357.7	62.2	4.2	1.6	1.6	5.1
	Middle	100 cm from the top	16.5	479.3	79.1	4.6	12.6	12.6	18.1
	Middle	50 cm from the bottom	14.8	505.8	75.0	4.6	13.9	13.9	19.8
07.03.	Edge 1	30 cm from the top	12.2	376.3	46.0	3.8	1.1	2.2	4.3
	Edge 1	100 cm from the top	13.7	475.5	65.3	4.0	1.3	2.1	6.0
	Edge 1	50 cm from the bottom	11.4	478.8	54.7	4.8	1.7	1.4	4.4
	Edge 2	30 cm from the top	16.7	384.2	64.2	3.8	2.3	4.9	4.9
	Edge 2	100 cm from the top	17.5	458.8	80.3	3.8	5.4	7.6	7.7
	Edge 2	50 cm from the bottom	14.7	449.4	66.0	3.8	3.9	2.6	7.0
	Middle	30 cm from the top	18.1	362.8	65.7	3.8	6.5	9.2	7.6
	Middle	100 cm from the top	17.3	439.2	75.8	3.8	14.5	15.1	15.9
	Middle	50 cm from the bottom	15.9	497.4	78.9	4.7	10.8	19.6	20.0
18.04.	Edge 1	30 cm from the top	19.4	340.5	65.9	3.8	14.7	14.8	15.0
	Edge 1	100 cm from the top	16.3	445.7	72.7	4.1	13.9	14.3	14.4
	Edge 1	50 cm from the bottom	15.7	463.9	72.7	4.5	15.0	13.9	12.7
	Edge 2	30 cm from the top	19.5	343.7	66.9	3.8	13.9	13.9	14.4
	Edge 2	100 cm from the top	16.9	440.1	74.3	3.8	12.4	12.6	12.5
	Edge 2	50 cm from the bottom	15.9	465.3	74.0	4.7	14.4	14.6	13.2
	Middle	30 cm from the top	18.1	399.6	72.2	3.8	12.6	15.5	16.0
	Middle	100 cm from the top	16.8	408.9	68.8	4.3	15.4	17.8	17.7
	Middle	50 cm from the bottom	16.9	537.0	90.8	4.9	15.8	19.4	19.4
		Mean value	**16.3**	**424.5**	**68.7**	**4.2**	**8.2**	**9.8**	**10.7**
		Minimum	**11.4**	**287.8**	**46.0**	**3.8**	**-0.8**	**1.4**	**4.3**
		Maximum	**19.5**	**537.0**	**90.8**	**4.9**	**15.8**	**19.6**	**20.0**

Table 2: Test results, arranged by the sampling positions

Date	Position	Layer	DMc	Density		pH	Temperature °C		
			%	kg DM/m^3	kg FM/m^3		15 cm	50 cm	150 cm
Jan 09	Edge 1	30 cm from the top	18.0	54	299	4.4	-0.8	3.2	4.8
Mar 09	Edge 1	30 cm from the top	12.2	46	376	3.8	1.1	2.2	4.3
Apr 09	Edge 1	30 cm from the top	19.4	66	340	3.8	14.7	14.8	15.0
Jan 09	Edge 1	100 cm from the top	14.9	68	456	4.3	2.2	5.0	5.0
Mar 09	Edge 1	100 cm from the top	13.7	65	476	4.0	1.3	2.1	6.0
Apr 09	Edge 1	100 cm from the top	16.3	73	446	4.1	13.9	14.3	14.4
Jan 09	Edge 1	50 cm from the bottom	14.3	63	439	4.4	3.5	5.2	5.3
Mar 09	Edge 1	50 cm from the bottom	11.4	55	479	4.8	1.7	1.4	4.4
Apr 09	Edge 1	50 cm from the bottom	15.7	73	464	4.5	15.0	13.9	12.7
		Mean value	**15.1**	**62**	**419**	**4.2**	**5.8**	**6.9**	**8.0**
Jan 09	Edge 2	30 cm from the top	18.3	53	288	4.3	-0.1	5.8	5.5
Mar 09	Edge 2	30 cm from the top	16.7	64	384	3.8	2.3	4.9	4.9
Apr 09	Edge 2	30 cm from the top	19.5	67	344	3.8	13.9	13.9	14.4
Jan 09	Edge 2	100 cm from the top	16.8	69	409	4.4	5.6	7.8	7.3
Mar 09	Edge 2	100 cm from the top	17.5	80	459	3.8	5.4	7.6	7.7
Apr 09	Edge 2	100 cm from the top	16.9	74	440	3.8	12.4	12.6	12.5
Jan 09	Edge 2	50 cm from the bottom	16.8	78	461	4.4	6.6	7.6	4.8
Mar 09	Edge 2	50 cm from the bottom	14.7	66	449	3.8	3.9	2.6	7.0
Apr 09	Edge 2	50 cm from the bottom	15.9	74	465	4.7	14.4	14.6	13.2
		Mean value	**17.0**	**69**	**411**	**4.1**	**7.1**	**8.6**	**8.6**
Jan 09	Middle	30 cm from the top	17.4	62	358	4.2	1.6	1.6	5.1
Mar 09	Middle	30 cm from the top	18.1	66	363	3.8	6.5	9.2	7.6
Apr 09	Middle	30 cm from the top	18.1	72	400	3.8	12.6	15.5	16.0
Jan 09	Middle	100 cm from the top	16.5	79	479	4.6	12.6	12.6	18.1
Mar 09	Middle	100 cm from the top	17.3	76	439	3.8	14.5	15.1	15.9
Apr 09	Middle	100 cm from the top	16.8	69	409	4.3	15.4	17.8	17.7
Jan 09	Middle	50 cm from the bottom	14.8	75	506	4.6	13.9	13.9	19.8
Mar 09	Middle	50 cm from the bottom	15.9	79	497	4.7	10.8	19.6	20.0
Apr 09	Middle	50 cm from the bottom	16.9	91	537	4.9	15.8	19.4	19.4
		Mean value	**16.9**	**74**	**443**	**4.3**	**11.5**	**13.8**	**15.5**

Table 3: Test results, arranged by the sampling layers

Date	**Position**	**Layer**	**DMc**	**Density**		**pH**	**Temperature °C**		
			%	**kg DM/m^3**	**kg FM/m^3**		**15 cm**	**50 cm**	**150 cm**
Jan 09	Edge 1	30 cm from the top	18.0	54	299	4.4	-0.8	3.2	4.8
Mar 09	Edge 1	30 cm from the top	12.2	46	376	3.8	1.1	2.2	4.3
Apr 09	Edge 1	30 cm from the top	19.4	66	340	3.8	14.7	14.8	15.0
Jan 09	Edge 2	30 cm from the top	18.3	53	288	4.3	-0.1	5.8	5.5
Mar 09	Edge 2	30 cm from the top	16.7	64	384	3.8	2.3	4.9	4.9
Apr 09	Edge 2	30 cm from the top	19.5	67	344	3.8	13.9	13.9	14.4
Jan 09	Middle	30 cm from the top	17.4	62	358	4.2	1.6	1.6	5.1
Mar 09	Middle	30 cm from the top	18.1	66	363	3.8	6.5	9.2	7.6
Apr 09	Middle	30 cm from the top	18.1	72	400	3.8	12.6	15.5	16.0
		Mean value	**17.5**	**61**	**350**	**4.0**	**5.7**	**7.9**	**8.6**
Jan 09	Edge 1	100 cm from the top	14.9	68	456	4.3	2.2	5.0	5.0
Mar 09	Edge 1	100 cm from the top	13.7	65	476	4.0	1.3	2.1	6.0
Apr 09	Edge 1	100 cm from the top	16.3	73	446	4.1	13.9	14.3	14.4
Jan 09	Edge 2	100 cm from the top	16.8	69	409	4.4	5.6	7.8	7.3
Mar 09	Edge 2	100 cm from the top	17.5	80	459	3.8	5.4	7.6	7.7
Apr 09	Edge 2	100 cm from the top	16.9	74	440	3.8	12.4	12.6	12.5
Jan 09	Middle	100 cm from the top	16.5	79	479	4.6	12.6	12.6	18.1
Mar 09	Middle	100 cm from the top	17.3	76	439	3.8	14.5	15.1	15.9
Apr 09	Middle	100 cm from the top	16.8	69	409	4.3	15.4	17.8	17.7
		Mean value	**16.3**	**73**	**446**	**4.1**	**9.3**	**10.5**	**11.6**
Jan 09	Edge 1	50 cm from the bottom	14.3	63	439	4.4	3.5	5.2	5.3
Mar 09	Edge 1	50 cm from the bottom	11.4	55	479	4.8	1.7	1.4	4.4
Apr 09	Edge 1	50 cm from the bottom	15.7	73	464	4.5	15.0	13.9	12.7
Jan 09	Edge 2	50 cm from the bottom	16.8	78	461	4.4	6.6	7.6	4.8
Mar 09	Edge 2	50 cm from the bottom	14.7	66	449	3.8	3.9	2.6	7.0
Apr 09	Edge 2	50 cm from the bottom	15.9	74	465	4.7	14.4	14.6	13.2
Jan 09	Middle	50 cm from the bottom	14.8	75	506	4.6	13.9	13.9	19.8
Mar 09	Middle	50 cm from the bottom	15.9	79	497	4.7	10.8	19.6	20.0
Apr 09	Middle	50 cm from the bottom	16.9	91	537	4.9	15.8	19.4	19.4
		Mean value	**15.2**	**73**	**478**	**4.5**	**9.5**	**10.9**	**11.8**

3.3. Fermentation quality

Mould formation and heating occur when silage is not optimally compacted and covered with tarpaulin. Both aerobic faulty fermentations were absent in the samples. This means that the low compaction combined with water-filled pores had no negative effects on fermentation quality.

All silage at the samplings in January and March was well fermented and free from mould, decay and faulty fermentation, particularly without butyric acid and reheating, regardless of the sample position and location in the silo.

In April, all silage was well fermented and free from mould, decay and reheating, regardless of the sample position and location in the silo. However, the lower layers did have some butyric acid, especially in the middle of the silo. Butyric acid fermentation is an anaerobic process caused by clostridia. These are only eliminated by intensive fermentation and good acidification. Therefore, the pH value should not exceed a limit value of 4.0 for DM contents lower than 20 %.

A pH value of 4.2 was recorded in the middle of the silage with a spread of 3.8 to 4.9 (Table 1). When comparing the positions, the Sudan grass silage at the edge sections (edge 1) had a slightly lower pH value at 4.2 than the silage in the silo middle at 4.3 (Table 2). In the silo the pH value decreased from the top downward from a mean 4.0 (layer 1) to 4.1 (layer 2) to a mean 4.5 (Table 3). This coincides well with the sensory assessment, which detected some butyric acid in the last sample, particularly in the lower section of the silo middle. However, as an anaerobic fermentation product, butyric acid has nothing to do with the compaction of the Sudan grass silage. There would probably have been much higher levels of butyric acid in equally damp grass silage. However, other tests by the Landwirtschaftliches Zentrum have shown that Sudan grass mostly has a high level of nitrate and this acts as an inhibitor against the clostridia in the silage in the reduced form of nitrite. Therefore, it has also been assumed in this test that natural nitrate has inhibited the clostridia as a kind of chemical silage additive over broad areas, despite the less than optimum acidification. It should be noted that butyric acid represents less of a problem for the biogas plant and more of a problem for the environment in terms of odours.

3.4 Temperatures

The sensory assessment of the fermentation quality corresponds well to the results of the temperature measurements. Mould formation and reheating did not occur in the silo regardless of the sample timing and the position and layer in the silo. Mould and reheating were also not detected at other locations in the silo that were not sampled, such as directly beneath the tarpaulin. Reheating, which is caused by yeast, occurs in silage temperatures of over 20°C. Up to 50°C has been measured in other Landwirtschaftliches Zentrum tests in poorly compacted silage that has not been covered with tarpaulin.

All measurements in the Sudan grass silage were under 20 °C up to a value of exactly 20 °C. The spread ranged from -0.8 to 20 °C, whilst the mean temperature increased slightly from the access edge into the silage pile from a mean 8.2 °C (15 cm deep) to 9.8 °C (50 cm deep) to 10.7 °C. However, this is less to do with reheating than the winter cooling of the damp silage at the surface. This observation is particularly supported by the measurements in the edge section (taken 15 cm in into the silage), which revealed a decrease in temperature from the middle (mean 11.5 °C) to 7.1 °C (edge 2) to 5.8 °C (edge 1) (Table 2). The cooling was also detected in the individual layers from the top downward from a mean 5.7 °C (measured at 15 cm deep) to 9.3 °C (1m from the top) to a mean 9.5 °C.

4. Evaluating the results

The dry mass content of the sudan grass silage decreased in the silo from the inside outward and from the top downward. These observations are the result of the low DM content overall and the displacement of fermentation liquid from the top downward and probably because rainwater had penetrated the edge area. These effects are typical in damp silage and, as a result, cannot be attributed to a negative effect of the snow groomer. Fermentation liquid occurs in all silage if it is ensilaged with less than 30 % DM. The mean DM content in the sudan grass silage was 16.3 %. Rainwater can penetrate if the tarpaulin cannot be pulled over the silo wall as in this test, but is laid flush against the wall.

The aim for silage is high compaction and hermetic sealing to encourage low-loss lactic acid fermentation and to prevent the spread of aerophile fermentation pests such as moulds and yeasts, as well as putrefactive bacteria. When the silage is removed from the silo, air voids allow oxygen to penetrate, which leads to mould formation and reheating if there has been insufficient pushing. Therefore, the push rate in winter should be at least 1.5 metres per week and in summer at least 2.5 metres per week. In this test, a push of around 2.8 metres per week was achieved in the period from the middle of January to the middle of April.

At 68.7 kg DM/m³ the mean density was only around a third of the compaction desired for grass and maize silage of over 200 to 220 kg DM/m³. The compaction in the uppermost layer and in the edge section with 62 and 61 kg DM/m³ was around 16 % below the compaction of 74 kg DM/m³ in the silo middle and in the layers from 100 cm from the top. Thus, greater care should be taken at the edge section and the uppermost layer from half a metre in each case. Re-rolling for an hour and targeted rolling at the silo wall are an advantage here.

According to new publications from RICHTER & OSTERTAG (2009), who have investigated the connection between compaction and the growth of undesired microorganisms, the target areas of optimally compacted silage must be adjusted downward, particularly in damp areas. According to these investigations, compaction of 155 to 165 kg DM/m³ is sufficient in grass silage with around 20 % DM. These values were also not achieved in this investigation. However, the question must be raised of whether the target ranges, which predominantly relate to grass and maize silage, can also be transferred to Sudan grass silage. In general, high compaction is obviously an advantage for anaerobic processes but, unfortunately, there are no comparative values available for Sudan grass silage. A positive effect was caused by the fact that in this case with damp Sudan grass the pores in the silage were filled with water rather than air, which allows oxygen into the feed during removal. The push rate of 2.8 metres per week in the cool part of the year up to the middle of April was also positive in this case.

The low compaction of almost 69 kg DM/m³ has had a negative effect on the fermentation quality of the silage. No aerobic spoilage such as mould formation, decay or reheating were observed at any time. No high temperatures were recorded at any time either. Thus, there is nothing to criticise in the Sudan grass silage in terms of faulty aerobic fermentation. The higher pH values, above all in the lower silo section, and the butyric acid detected in sensory tests in April are due to anaerobic clostridia. This process is not due to silage compaction and does not have a negative effect on silage evaluation in the biogas plant.

5. Summary

In October 2008, sudan grass was cut, spread and compacted in a bunker silo using a PistenBully 300. The harvest and unloading were effected without the involvement of LAZBW. A total of 1,931 tonnes of fresh mass were unloaded with a mean output of 92.8 t FM/h according to the electronic weight records.

The Sudan grass silage was sampled by the LAZBW during removal in January, March and April 2009 (start, middle, end of the removal period) and was tested with regard to compaction, fermentation quality and temperature. Three core samples were removed at three positions (edge 1, edge 2, middle of the silo) and layers (0.30 m, 1.00 m from the top; 0.50 m from the bottom) on each occasion and the temperature in the bore holes was measured at three depths (15 cm, 50 cm, 150 cm).

The results can be summarised as follows:

1. The mean DM content of the Sudan grass silage was 16.3 %. It decreased in the silo from the inside outward and from the top downward. These effects are mainly due to the damp harvested crop and the displacement of fermentation liquid.

2. The mean density was 68.7 kg DM/m³. In the uppermost layer and in the edge section (61 and 62 kg DM/m³) it was around 16 % below the compaction in the silo middle and in the layers from 100 cm (74 kg DM/m³).

3. The mean push rate for the removal was around 2.8 metres per week in the period between January and April 2009.

4. The low compaction has not had a negative effect on the fermentation quality of the Sudan grass silage because of the high removal rate. It was noted positively that the pores in the damp silage were filled with water rather than air.

5. Therefore, the question must be asked whether the target ranges for grass and maize silage at over 200 kg DM/m³ can also be transferred to damp Sudan grass silage and whether damp sudan grass can be compacted more densely. There are no comparable values in the literature.

6. No aerobic spoilage such as mould formation, decay or reheating were observed anywhere in the silage at any time.

7. In April, higher pH values (up to 4.9) were detected and some butyric acid was detected in the sensory testing. Butyric acid formation is not based on the activity of the anaerobic clostridia and is not connected to the silage compaction.

8. The temperature in the silage did not exceed 20 °C at any time. The temperature in the silage decreased from the inside outward and from the top downward. This is due to the cooling process at the surface and not to reheating in the silage.

These results show that use of the snow groomer (PistenBully 300) for silaging damp sudan grass had no negative effect on the quality of the sudan grass silage and the evaluation of the silage in the biogas plant.

6. Responsible for the results

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