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Field-related quality management system for grass silage production

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Introduction The production of high-quality grass silage depends on a wide range of factors, e.g. species composition, plant nutrient supply, morphological stage at mowing, mowing and wilting procedures, weather conditions during wilting and ensiling, dry matter (DM) content of the ensiled grass, use of additives as well as compaction and sealing in the clamp. In general, the evaluation of silage quality and possibly occurring weaknesses within the silage production system is based on laboratory analysis of a core sample taken before or a sample taken at feeding. However, in larger clamps filled with grass from different fields, it is hardly possible to refer the analysis results to the grass swards of the single fields. It was the objective of the work to contribute to a silage quality management system, where the clamp and the single fields are linked. Based on this link, it is possible to discover weaknesses in the whole silage production system, starting at the grass sward, covering the period of mowing, wilting and chopping and ending at the filled, compacted and hermitically covered clamp.

Material and Methods The silage quality management system was developed for larger farms in the 1980´s and tested again in 2002 and 2004 (Pickert and Weise 2014). In cooperation with seven farms in Northern Germany in 2015 and 2016, the system was further developed on the base of two prediction models, *WiltExpert* (Pickert et al. 2016) and *SiloExpert* (Pickert et al. 2018). During the studies in 2015 and 2016, it was possible to satisfactorily predict the time of ensiling at an optimal DM content of the grass and to predict the net-energy lactation (NEL) content on different fields with a very good modelling efficiency and a low predictive error (Table 1).

Table 1. Mean Absolute Error (MAE) and Modelling Efficiency (EF) of the used models in 2015 and 2016 (Pickert et al. 2016 and 2018).

model	prediction at	prediction of	n	MAE	EF
WiltExpert	mowing	time of ensiling	16	108 minutes	0.99
SiloExpert	ensiling	silage energy concentration	16	0.14 MJ NEL kg DM^{-1}	0.93

Table 2. Evaluation of fodder quality parameters in different phases of the silage production process.

phase	mowing	ensiling	feeding
material	new mown grass	wilted grass	grass silage
scale	field	field	clamp
g fresh matter (FM) kg dry matter $(DM)^{-1}$	+	□	■
g crude fibre DM^{-1}	□	□	■
g crude protein kg DM^{-1}		+	■
g sugar kg DM^{-1}			■
MJ Net-Energy Lactation kg DM^{-1}		+	■
Cation and anion content (e. g. K, Na, Mg, Ca, P, S, Cl)	□	□	■

■ silage-related analysis, □ field-related analysis, + field-related model based estimation

The silage quality management system is collecting and evaluating data and information of the grass´ DM and nutrient content, its ensilability and the ensiling conditions instead of conventional silage evaluation of samples at feed-out (Table 2).

In 2017 the silage quality management system was tested in an additional farm of the region.

Results and Discussion During the study in 2017, a great variation was found within the grass material from the different single fields contributed to the clamp at ensiling. Only on a limited number of fields, the grass energy content fulfilled the feed requirements of high-yielding milking cows, whereas it was below the need on various other fields. According to the clamp filling flow, six grass bulks with different quality characteristics were identified in different parts of the clamp (Table 3). The minimum size of a clamp part depends on the size and shape of the clamp as well as on the filling and feed-out techniques in the farm. Although the average silage DM content of the whole clamp was in the expected range between 350 and 450 g FM kg DM^{-1}, the DM content of the ensiled grass on several single fields was above the optimum. It is necessary to check and perhaps to change the existing harvesting procedure in this farm in order to minimize the risk of exceeding the optimum DM range.

Table 3. Silage quality in different parts of a clamp (Organic dairy farm Münchehofe, 1st cut, 2017; clamp 3m high, 12m wide; 40m long; weighted means; bulk density 0.2 t DM m^{-3}).

clamp part	1	2	3	4	5	6	total
No. of single fields per clamp part	6	4	2	3	6	4	25
m per clamp part	10.72	4.38	4.23	4.40	6.30	10.31	40.34
m cumulative	0.00	10.72	15.10	19.33	23.73	30.03	40.34
m³	386	158	152	158	227	371	1452
t DM	77	32	30	32	45	74	290
mean g FM kg DM^{-1}	460	434	413	323	480	488	448
min g FM kg DM^{-1}	383	418	384	298	324	336	298
max g FM kg DM^{-1}	614	447	469	531	676	573	676
GJ NEL	476	184	189	182	277	417	1724
mean MJ NEL kg DM^{-1}	6.16	5.85	6.19	5.75	6.10	5.62	5.94
min MJ NEL kg DM^{-1}	6.01	5.75	6.15	5.58	6.07	5.47	5.47
max MJ NEL kg DM^{-1}	6.28	5.92	6.26	5.77	6.23	6.09	6.28
t crude protein	11	5	5	5	7	10	43
mean g crude protein kg DM^{-1}	146	148	171	145	153	134	147

Conclusion On the fields where the grass was harvested at very low energy contents, the farmer has to check and possibly change the sward species composition and/or harvest at an earlier morphological stage. On the fields harvested with too high DM contents, he has to check and possibly change the harvesting procedure. Based on the results of the silage management system, the farmer can ensure the optimal utilization of the produced grass silages depending on the farms´ need and according to the silage quality.

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