Silage making: The first days of life of your annual profit.

Microorganisms are the single most diverse group of living organisms on the planet. They are required by every living animal and plant in order for them to survive – they colonise every environment and lead to a variety of environmental transformations, but, like animals, they are adapted to their environmental conditions – temperature, oxygen concentration, nutrient supply, acidity and moisture content. If we change the environmental conditions we also change the ability of the microorganism to survive – like a fish out of water.

Bacteria are the catalyst for silage fermentation. Without the appropriate bacteria and conditions our ensiled forage will turn into compost. The silage is therefore a dynamic ecosystem as below.

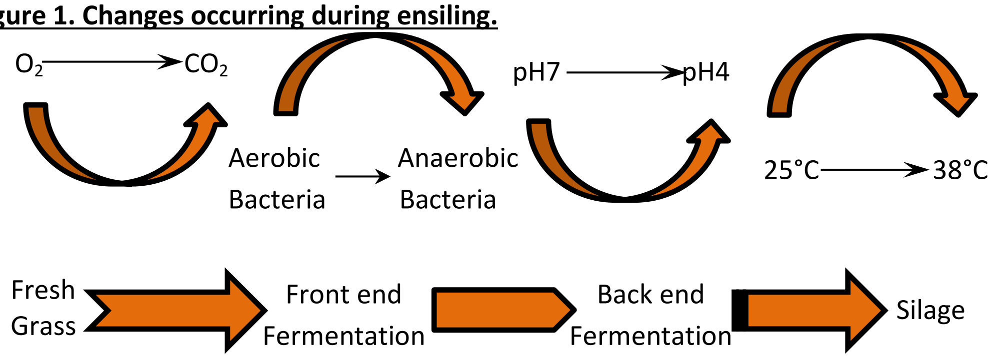
Table 1. Bacteria naturally contained in forage.

	Total Count	Lactic Acid Bacteria	Yeast and Fungi	Clostridia	pH
Un cut grass	1,200	100	<10	1,000	6.2
Wilted (+25hrs)	2,900,000	17,000	30	1,000	
Harvested (+32hrs)	4,600,000	720,000	<10	1,000	6.2
Silage – Day 1	650,000,000	10,000,000	373	10,000	5.9
- Day 3	1,700,000,000	7,300,000	46	100,000	4.9
- Day 8	3,200,000,000	3,900,000,000	46,000	100	4.6
- Day 23	200,000,000	40,000,000	140,000	<10	4.3

Adapted from McDonald

Dramatic changes occur in the ensiled grass environment over the first week of ensiling, leading to dramatic changes in the population of microorganisms within the ensiled grass. The following table shows the progression of microorganisms over the first days of ensiling untreated wilted perennial ryegrass.

Figure 1. Changes occurring during ensiling.



Within this microbial population, <u>only</u> the homofermentative Lactic Acid Bacteria are efficient at fermenting the sugar to acid. The Lactic Acid Bacterial populations in untreated silage are dominated by heterofermentative LAB with 85% of the LAB being heterofermentative 4days into the fermentation and between 75 – 98% of the LAB being heterofermentative in the final untreated silage (Beck) dependent on the forage dry matter.

The significance of the relative bacterial make-up for the farm profit is very clear when considering how efficient the different groups of bacteria are at fermenting sugar:

Table 2. fermentation process by kind of bacteria.

Microorganism	PRODUCTION	Loss (%)	
		DM	Energy
Homofermentative LAB	Glucose + 2ADP $\longrightarrow$ 2 Lactate + 2 ATP	**0**	**0.7**
Heterofermentative LAB	Glucose + ADP $\longrightarrow$ Lactate + Ethanol + CO_2 + ATP	**24**	**1.7**
Clostridia	2 lactate + ADP $\longrightarrow$ Butyrate + $2CO_2$ + $2H_2$ + ATP	**51.1**	**18.4**
Yeast	Glucose + 2ADP $\longrightarrow$ 2 Ethanol + $2CO_2$ + 2ATP	**48.9**	**0.2**

(McDonald) DM = Dry Matter

Once the fermentation is complete and the final, stable pH has been reached, dry matter, energy & feed value losses are stopped (assuming good silage management practise)

The use of silage inoculant to dominate the fermentation is very well accepted, with the logic of using the inoculant initially being simply to out-compete the naturally occurring recycling bacteria that dominate the fresh forage, but now good quality inoculants are also expected to enhance the quality of the final silage (eg digestibility). Long standing criteria have been defined for what an effective inoculant should compose, and drawing back on the initial statements regarding the enormous transformations that the fresh forage goes through in the first few days of ensiling (the increase in temperature toward the mid 40 – 45°C, the 1000 fold increase in acidity, the change in environment from 21% oxygen to 0% oxygen) it is clear that to be effective any inoculant must contain multiple strains that can ferment at different areas of the fermentation and also be present in sufficiently high numbers to dominate throughout the fermentation.

Good Silage Inoculant Requirements

1. Grow vigorously and dominate the fermentation
2. Be Homolactic
3. Be acid tolerant and capable of reaching pH4
4. It must ferment wide range of sugars
5. It must not produce dextran
6. It must not affect organic acid
7. It should grow up to 50°C
8. It should grow at high DM

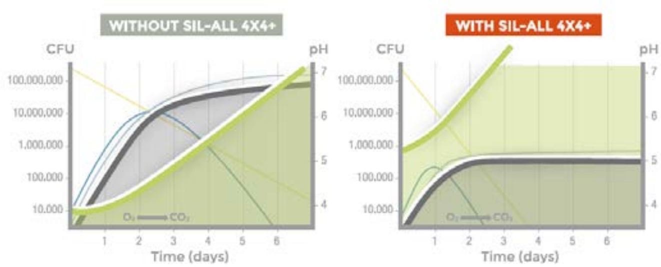
Consider a farm example of the effect of pH on bacteria – the rumen, and then consider the effect of modest changes in the pH of the rumen on the efficiency of the animal. Optimal rumen pH is between the range of pH6.0 and 6.4, but when the rumen is exposed to lower pH (as in sub acute rumen acidosis) there is an enormous destabilisation of the rumen microbiology (Nagaraja and Titgemeyer, 2007). A reduction of pH from 6.0 to 5.5 for a short period of time (as in SARA) leads to this microbial fluctuation which is based on a 50 fold increase in acidity within the rumen (every unit of change of pH represents a 10 fold increase in acidity). When making silage the fresh forage goes through a 1000 fold increase in acidity and for the forage fermentation to be effective, it is necessary to have a range of homolactic organisms in a silage inoculant to dominate and drive the fermentation and inhibit the growth of spoilage organisms that reduce the feed value at feed out.

The first few days of the life of the bunker define the nutritive value of the silage that will be fed to the dairy or beef animals through the efficiency of the fermentation, but also define the stability of the silage at feed out. The population of yeast present in the silage defines how stable the silage will be at feed out. Yeast will increase in numbers whilst oxygen is present, and the population of yeast changes from ‘general yeast’ to ‘acid loving yeast’, and it is these ‘acid loving yeast’ that cause heating when the bunker is opened and the silage is exposed to air. By compacting the forage well, treating the forage with a product that will work across all dry matters and pH ranges, and keeping the oxygen out through good management practises the optimal environment is created to maximise the nutrient and dry matter retention of the ensiled forage.

Silage – more than meets the eye, more than meets the rumen.

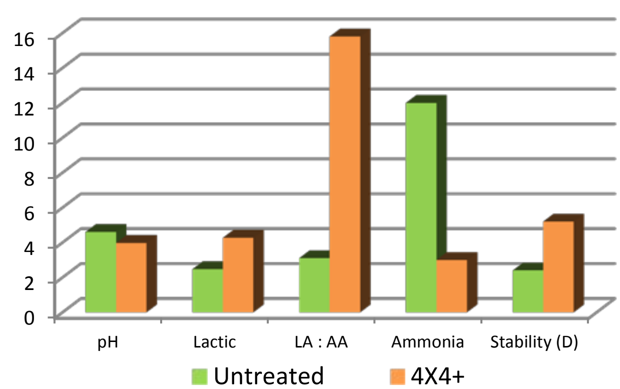
What about Sil-All 4X4+?

1. ***Increase of fermentation speed within the few days of ensiling:***



With the addition of 1.000.000 positive bacteria, oxygen in silage is quickly converted within the few days of storage. With a quicker fermentation start, Sil-All4X4+ limit growth of bad organisms, energy and dry matter loss.

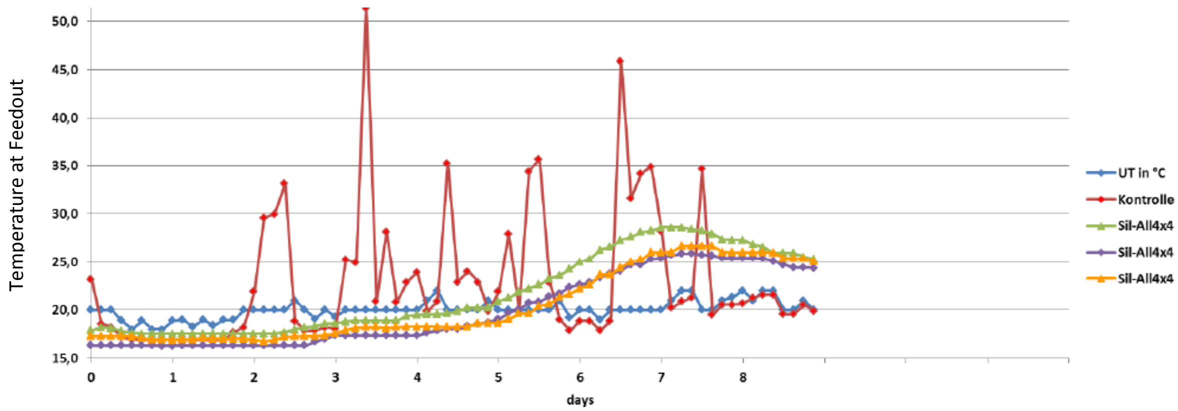
2. ***For a better quality silage:***



Thayssen, Landwirtschaftskammer Schleswig-Holstein, 2013 34% DM Grass

Fermentation characteristics of grass were statistically enhanced by treatment with both Sil-All 4X4+ and Fireguard, achieving a much more stable pH more rapidly, protecting statistically more protein through treatment and ultimately leading to an increase of stability by 3 days with Sil-All 4X4+ and 9 days with Fireguard. Treated silage both had a DLG score of 100, whereas the untreated silage had a DLG score of 64. (lactic and ammonia values are quoted as g/Kg, stability in days)

3. *For an enhance stability all year long*



Thayssen, Landwirtschaftskammer Schleswig-Holstein, 2013

58% DM Red Clover

Silage treated with Sil-All 4X4+ has a controlled fermentation which in turn controls the microbiology of the silage through the ensiling and storage process. This process leads to much greater stability of the silage compared to the untreated silage. At feed out the untreated silage, once exposed to air, rapidly starts to heat…increasing in temperature up to 50°C, with heating occurring within 2 days – Sil-All 4X4+ treated silage remains stable for a further 4 days, and when the silage ultimately heats the maximum temperature achieved is lower than 30°C, protecting more energy and feed value.

Gordon MARLEY
Sil-All Product Manager
gmarley@sil-all.com