DUPONT PIONEER

TECHNOLOGY THAT **YIELDS**

Fermentation Process

Silage fermentation can be simplified into three phases. Silages experience aerobic (with oxygen) conditions during harvest and filling, followed relatively quickly by anaerobic (without oxygen) conditions which initiate lactic acid bacterial growth and pH decline, and finally, back to aerobic conditions during feedout.

Dry matter loss (shrink) begins with plant cell respiration and aerobic microflora utilising carbohydrate sources (primarily sugar) producing water, heat and carbon dioxide (CO_2). It is this carbon, lost to the atmosphere, which causes shrink loss. Wilting time and speed of harvest impact the extent of these aerobic field losses. These processes will continue until the oxygen in the silage mass is depleted. Plant moisture and compaction play a role in reducing the length of this aerobic phase in the storage structure by reducing silage porosity.

The subsequent anaerobic phase establishes an environment suitable for domination by homofermentative and heterofermentative lactic acid bacteria (LAB). There would be no shrink loss in this phase if only homofermentative LAB were active. However, less than 0.5% of epiphytic organisms naturally found on fresh crops are LAB and only a small proportion of these are homofermentative. To put the loss from heterofermentative LAB in perspective, there is a 24% loss of dry matter from the heterofermentative fermentation of glucose. These anaerobic fermentation losses can be reduced by 25% or more with the use of homofermentative strains found in reputable silage inoculants. The re-exposure of silage to aerobic conditions can be divided into two areas: top and side exposure with upwards of 20% of silage contained in the top three feet in most bunkers and drive-over piles, and face exposure during feedout.

The combination of these two sources of shrink loss can vary significantly due to management level with estimates of greater than 20% loss in net energy (in pure starch equivalents) reported in the literature from aerobically unstable silages. The increased use of bunkers and piles with large exposed faces (as opposed to smaller face exposure in tower silos or bags) results in significantly more shrink in the aerobic, feedout phase than in the initial aerobic phase.

Several technologies can be employed to reduce top and face spoilage including specialised packing equipment, oxygen-barrier film, silage facers and bacterial inoculants containing *Lactobacillus Buchneri*. The fact that *L. Buchneri* is a heterofermentative LAB may lead to questions as to why inoculant manufacturers would use a LAB known to be less efficient than homofermentative strains. They are used because the metabolites of their growth inhibit yeast growth during feedout, and it is yeast which initiates the cascade of events leading to aerobic losses. In addition, most products containing *L. Buchneri* also contain homofermentative strains to facilitate a rapid, "front-end" pH decline.

For more information regarding ensiling crops and Pioneer Inoculants please contact your local Pioneer Area Manager or Pioneer Promoter Agent.

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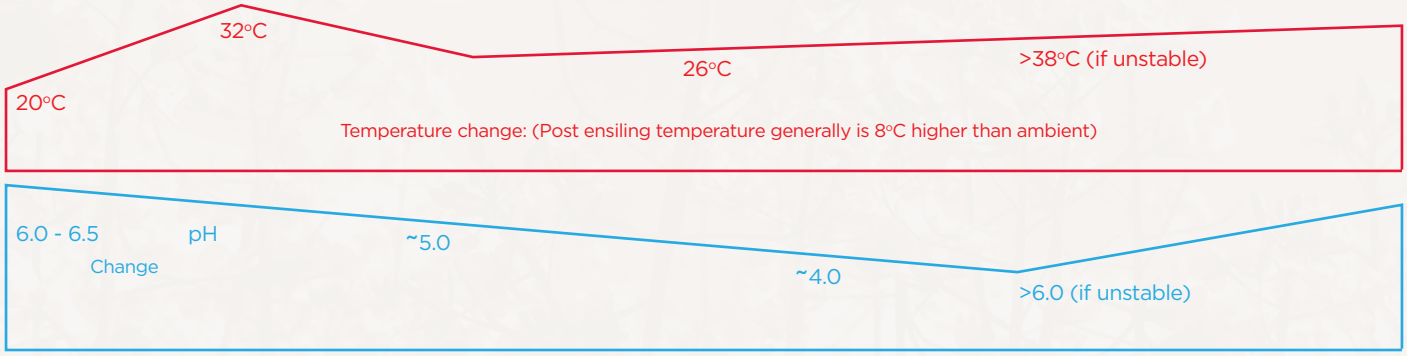
Fermentation Process

Phases of Silage Fermentation and Storage

LAB - lactic acid bacteria
WSC - water soluble carbohydrate

Aerobic Phases		Anaerobic Phases			Aerobic Phases
Cell respiration and aerobic organisms consume WSC with production of CO_2 heat and water.	Populations of enterobacter and heterofermentative bacteria yielding lactic acid, acetic acid and ethanol.	Transition phase with shift to more homofermenatitive LAB's.	Primary homofermentative LAB phase. Efficiency depends on epiphytes levels, WSC, moisture and compaction.	Increases in protein solubility and starch digestibility occur during this phase.	Secondary aerobic decomposition upon re-exposure to oxygen. Highly influenced by feed-out rates and face management.



Continues until all O_2 is consumed. High carbohydrate and protein enzymatic activity.	Acetate-tolerant bugs drop pH to ~5.0. Low pH reduces microbial activity. Lasts 24-72 hours.	Homofermentative LAB's initiate more rapid and efficient drop in pH.	Longest phase lasting until run out of WSC or terminal pH inhibits growth.	Stability impacted by O_2 penetration residual WSC, acid profile, microbial and fungi populations.	Yeast, mold and aerobic bacteria activity causing 50% of total DM losses.
12-24 hrs	2-3 days	←	Time to terminal pH is crop dependent related to amount of sugar and crop buffering capacity. Can range from as short as a few days with corn silage to as long as 2 months with dry (<24% moisture) high moisture shelled corn. Time can be reduced by half with a reputable inoculant.	→	