REDUCING NUTRIENT LOSSES
Use of additives in silage production

Use of a right type of additive for crops being ensiled decreases dry-matter losses during storage and prevents heating of the silage during feed-out, thereby decreasing total DM losses from the silage.

Losses of nutrients during extended wilting of forage under rainy weather conditions in the field and during storage and feed-out of silage increases feed costs because lower quality silage needs to be supplemented with more complementary feed of high protein quality and energy content to fulfil the nutrient requirements of dairy cattle. Good harvesting techniques with quick and uniform wilting of the forage in the field to an appropriate dry-matter (DM) content for the silo or bale are important to minimize DM losses. Also, thorough compaction of the forage in the silo between loads and before sealing of the silo with plastic film and cover material is crucial to minimize DM losses. Likewise, baled silage needs to be wrapped with sufficient layers of plastic film.

However, rain showers during wilting decreases DM and sugar contents of the forage, resulting in greater risks for clostridial fermentation of sugars and lactic acid to butyric acid, which in association with

breakdown of protein to ammonia, increases the pH of the silage. In dry and hot weather, the forage can dry too quickly and the high DM content increases the risks for air infiltration and growth of yeasts. This is accelerated when the silo is opened during feed-out, causing heating and risks for mould growth with significant DM and digestibility losses in the silage as a result. Similar problems occur when the silo or bale is not tightly sealed. To minimize risks for clostridial fermentation and aerobic deterioration, use of silage additives is recommended.

Chemical additives: acids and salts

The **acids** are formic, sorbic, benzoic, propionic and acetic acids. Depending on application rate and the use of buffered or unbuffered, formic acid can cause a direct acidification and suppression of undesired spoilage bacteria, with improved silage preservation as a result. Sorbic, benzoic, propionic and acetic acids directly inhibit yeasts and moulds, and thus improve aerobic stability of the silage at feed out. Sorbic acid also can be inhibitory to some bacteria, such as clostridia.
The **salts** calcium formate, sodium formate, ammonium formate, sodium nitrite and hexamethylene tetramine (hexamine) improve silage fermentation by suppressing spoilage bacteria. The salts sodium benzoate, potassium sorbate, ammonium propionate, calcium propionate, sodium propionate and sodium acetate inhibit yeasts and moulds by release of the respective acid in silage, thereby improving aerobic stability.

To achieve a broad spectrum of activity against spoilage bacteria and fungi, commercial additives often contain mixtures of these active ingredients at various concentrations.

Biological additives

These types of additives contain lactic acid bacteria, in some cases supplemented with fibre-degrading enzymes, to release some sugars for the lactic acid bacteria. There are **three main types of biological additives**. The first contains so-called homofermentative lactic acid bacteria, mainly producing lactic acid, which decreases silage pH quickly to around 4, to achieve stable storage conditions. The second contains heterofermentative lactic acid bacteria, which ferment sugars to both lactic and acetic acid and convert lactic acid to acetic acid. Acetic acid prevents heating of the silage during feed-out. A third type contains both homo- and heterofermentative lactic acid bacteria giving a dual action for quick pH drop and prevention of heating of the silage.

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Selecting the right additive for your purpose

Bunker and tower silos 25-35% DM (chopped or cut)

	Conditions	Action needed	Types of additive
Grass and Grass-clover silage	Low DM content < 25% DM	Inhibit clostridia	Acid or salt
	Legume dominating (low sugar and buffering)	Decrease pH quickly	Acid or inoculant with homofermentative lactic acid bacteria (LAB)
	Delayed harvest, low sugar content	Decrease pH quickly, inhibit clostridia, yeast and mould	Acid or salt
	Normal harvest time, high sugar content, good conditions, ca. 30% DM	Decrease pH quickly, inhibit yeast	Acid, salt or dual purpose inoculant with homo- and heterofermentative LAB
Whole-crop cereals/ maize	Whole-crop cereal harvested at heading	Decrease pH quickly, inhibit yeast	Acid, salt or dual purpose inoculant with homo- and heterofermentative LAB
	Whole-crop cereal harvested at dough stage and maize	Prevent heating of the silage	Salt or inoculant with heterofermentative LAB

Round bales 30-50% DM

	Conditions	Actions	Types of additive
Grass and Grass-clover silage	Low DM and/or legume dominating	Inhibit clostridia	Acid, salt or inoculant with homofermentative LAB
	Delayed harvest, low sugar content	Inhibit clostridia, yeast and mould	Acid or salt
	Normal harvest time, high sugar content, 40-50% DM	Inhibit yeast	Salt or dual purpose inoculant with homo- and heterofermentative LAB
Whole-crop cereals	Whole-crop cereal harvested at heading	Decrease pH quickly, inhibit yeast	Acid, salt or dual purpose inoculant with homo- and heterofermentative LAB
	Whole-crop cereal harvested at dough stage	Decrease pH quickly, inhibit yeast	Salt or inoculant with both homo- and heterofermentative LAB or heterofermentative LAB only

FARMER CASE

Kristoffer Kullingsjö´s strategy to minimize losses in silage making

Kristoffer (Kullingsjö Lantbruk AB) is a EuroDairy pilot farmer, located in Vårgårda, in south-west Sweden. For him, high quality grass-clover silage is the base for achieving well balanced feed rations for the high-yielding dairy cows on the farm. Grass-clover forage is harvested four times a year to obtain silage with high energy and protein contents. The forage is wilted in the field to ca. 30% DM before being precision chopped. An acid product containing formic acid, propionic acid and sodium formate is applied to the forage at recommended dosage in the precision chopper. During filling of the bunker silo, two 12-tonne trucks are packing the forage between loads and at the end of filling. The forage is covered with a plastic film along the sides of the silo and double wrapped on top. The plastic film is covered with a net and gravel bags are put along the sides and across the net to keep it down. Kristoffer uses silage additives as he wants to minimize DM losses during storage and feed-out, which results in a highly digestible silage for his dairy cows.

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