BIO-SIL®

Silage additive

Grass silage

A·B·CERT

EXCELLENT

IFTA AG
Natürlich. Für Zukunft.

DLG TestService

GMP+

BIO-SIL® is a DLG approved silage inoculant for use on all silage up to 35% dry matter. BIO-SIL® is a sublimated bacterial culture consisting of the homofermentative Lactic Acid Bacteria, Lactobacillus Plantarum DSM 8862 and Lactobacillus Plantarum DSM 8866 strains. Every batch of BIO-SIL® is tested twice for bacterial quantity and activity prior to shipment. These highly effective strains are specially selected naturally occurring bacteria that have not been altered or genetically modified in any way therefore BIO-SIL® inoculant may be suitable for organic status forage preservation. An inoculation rate of 300,000 cfu / gram of fresh material is sufficient to ensure stable fermentation if applied correctly. BIO-SIL® improves fermentation for forage crops in a wide variety of conditions from easily ensiled high sugar grasses to more challenging low sugar high lignin forage.

Ensilability	Crop types	Characteristics	Fermentability
Poorly ensiled silage	Italian and Perennial rye grasses, legumes	Low sugar levels and low dry matter content	Below 35
Moderate ensilable forages in DM range ≤35%	Grass, legumes, silage maize, grain leafy mass	Sufficient quantity of fermentation sugars	Over 35
Moderate ensilable forages in DM range ≥35%	Grass, legumes, silage maize, grain leafy mass	Sufficient quantity of fermentation sugars	Over 35

BIO-SIL® is supplied in 100-gram aluminium foil packs with each bag being sufficient to treat 100 tonnes of fresh silage material. This dosing rate will ensure the correct 300,000 cfu/ gram application is achieved. Each pack should be dissolved into 100 litres of un-chlorinated fresh water. Where un-chlorinated water is not available, BIO-SIL® offer the Chlor-ex additive to counteract the effects of chlorine on the bacterial culture.

Why is the use of Lactobacillus bacteria advisable for the production of high quality silage?

- Fresh forage naturally contains large fluctuations in bacterial populations along with undesirable yeasts and mold fungi. These are a particular problem in first cut grass silage, leafy wholecrop silage and grasses in multi cut systems.
- The bacteria naturally found on forage crops have very variable ability to produce large quantities of lactic acid and it is impossible to predict the lactic acid production ability of the fresh forage based on crop type, variety, maturity or agronomy.
- In 80% of all cases the naturally occurring mix of crop bacteria is insufficient to achieve a raid drop in pH (less than 3 days) that is required for high quality silage.
- BIO-SIL® silage inoculant applied correctly will ensure rapid pH drop, minimising dry matter losses and ensuring high quality stable silage is produced.

What are the specific advantages of BIO-SIL® silage inoculant?

- ✓ Rapid drop in pH to 4.00 to 3.90 after the first 2 to 3 days of ensiling.
- ✓ Optimal inhibition of undesirable coliform bacteria.
- ✓ Dry matter losses during fermentation reduced by up to 3%.
- ✓ Increase in digestibility by 2-3%.
- ✓ Increased energy concentration by up to 0.3 MJ NEL/kg of dry matter.
- ✓ Increased milk yield by around 1 litre per cow per day on average.
- ✓ Good fermentation thermal control ensuring silage does not exceed the optimal 37.7°C.
- ✓ Increased lactic acid concentration (80% or above) of organic acids within silage.
- ✓ Increased silage palatability leading to increased dry matter intakes.
- ✓ Suitable for uses over the widest range of crop types and dry matters right up to 35% DM without additional aerobic stability enhancers.
- ✓ Long tank life.

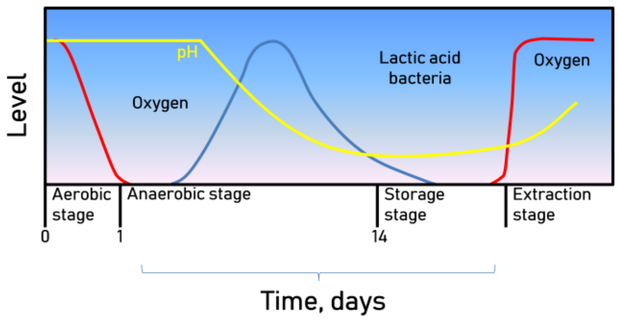
To exploit all the potential benefits of BIO-SIL® good silage making is essential.

- Fast clamp filling
- Good compaction
- Rapid and efficient clamp sealing
- Correct feed out rate of 2.0m per day

Silage Technology

The ensiling process relies on plant sugars being fermented into organic acids by anaerobic bacteria. The resultant pH drop creates conditions where molds, yeasts and other undesirable bacteria are unable to thrive. Lactic acid bacteria are key to this process since they produce a pH that is so low all microbial activity ceases and the silage is held in a state of preservation. Until the pH drops to around 4.0, the rival bacteria, molds and yeasts in the silage will be using up the crop sugars and can also be producing toxins.

The main chemical and microbial changes in the silage during fermentation can be divided into 4 stages as noted below – aerobic, anaerobic fermentation, storage and retrieval.



Aerobic stage

The aerobic stage commences as soon as the crop is harvested and continues until all the oxygen is depleted. If the silage is not effectively sealed, aerobic conditions will continue. In the initial phase, numerous yeasts and molds can be found together with a mix of bacteria including lactic acid producing lactobacillus. These microbes begin using up the oxygen and the crop sugars (that become available once the crop is cut), producing CO2, ethanol and organic acids. This activity causes a loss of dry matter and also produces heat leading to a rise in the clamp temperature. If the temperature rises above 37.7°C proteins within the silage can be de-natured making them unsuitable for livestock digestion. In addition, proteins can be subject to proteolysis that breaks down the protein into nitrogen, peptides, amino acids and ammonia. This effect depends on the pH value, the clamp temperature and the moisture content. In high dry matter grass and maize silage, the non-protein nitrogen levels can increase from 20% to 50% during the first 24 hours after ensiling. Proteolysis is particularly undesirable when feeding dairy cattle as the excess of soluble nitrogen can lead to poor absorption of other nutrients in the diet as well as a reduction in feed intake.
With good techniques and by using appropriate silage inoculants, the aerobic stage can be kept to an absolute minimum. This will reduce losses and increase the quality of the silage.

Anaerobic Fermentation Stage

The anaerobic fermentation stage starts as soon as all the oxygen in the silage has been depleted. The action of any aerobic micro organisms stops and a sequential chain of different anaerobic bacterial populations ferment plant sugars producing lactic and acetic acids along with ethanol and carbon dioxide. The resultant drop in pH produces conditions that inhibit the growth of other microbial populations.
Lactic acid bacterial activity continues in these conditions. Lactobacillus bacteria are divided into 2 distinct categories - homofermentative bacteria drpos PH more rapidly heterofermentative bacteria.
Both groups are able to produce lactic acid reducing the silage pH down to around 5.0. At this point the activity of heterofermentative bacteria ceases. Homofermentative bacterial activity can continue until conditions reach stability at pH

4.0 or lower, or until the available crop sugars are exhausted.

In silage with insufficient homofermentative bacterial populations, heterofermentative populations can thrive and produce acetic acid within the silage. This leads to a much slower drop in pH and during this time more silage dry matter will be lost to microbial activity. This process also produces acetic silage that is less palatable to livestock than lactic silage giving lower daily dry matter intakes.

The anaerobic fermentation stage ends when the pH within the silage is stable at 4.0 or less and all bacterial activity ceases. This may take around 7 days in high dry matter silage and may be quicker in lower dry matter crops.

Storage and retrieval stages

Silage will remain stable with no (or insignificant) losses of dry matter or nutrients as long as the silage has a low pH and is not exposed to oxygen. Oxygen stimulates the growth of yeasts and molds within the silage. Their activity leads to a loss of dry matter and generates heat that can be seen in an increase in the temperature within the clamp. The amount of spoilage losses on the surface is directly related to the compaction and sealing of the silage.

Once the clamp is opened and the silage is being retrieved, areas will become exposed to the oxygen in the atmosphere. In low density poorly compacted or high dry matter silage, the penetration of oxygen can lead to losses as high as 40% of the total crop dry matter. Rapid movement through the clamp (2m per week) will reduce the aerobic losses at the silage face.

The advantages of lactic acid fermentation

Although silage could be preserved using chemical preservatives, lactic acid fermentation is much more cost effective. Key points and advantages of a BIO-SIL® fermentation include:

- The inoculants produced with osmotolerant strains of lactobacillus bacteria are relatively cheap and are environmentally safe.
- Lactobacillus bacteria differ from other acid producing bacteria as they remain highly active in an acidic environment. Lactic acid levels build up quickly in the first 3 days after ensiling and the pH can rapidly drop to 4.0 or below producing highly stable silage. Fermentations including high levels of acetic or butyric acids are unable to achieve these stable conditions.
- The activity of acetic acid producing bacteria, yeasts and molds are all halted at pH 5.0 or below. The low pH and anaerobic conditions created in a lactic acid fermentation reduce DM losses and prevent the breakdown of proteins in the silage.
- High levels of lactobacillus activity prevent silage heating beyond the 37.7°C threshold. This also prevents protein degradation and reduces sugar losses.
- Silage produced in a lactic acid fermentation remains palatable and appetising to livestock promoting dry matter intakes. Presence of high levels of acetic acid will reduce forage intake and high levels of butyric acid make silage even less palatable.
- Once within the rumen, lactic acid undergoes rapid metabolic transformation and conversion into glucose. By contrast ingestion of acetic acids can cause disruption of the digestion process. Dissociation of two molecules of acetic acid in the rumen produces butyric acid. Semi-metabolic products (ketone bodies)

accumulate in the blood due to excessive butyric acid and this can induce ketosis in animals. Lactic acids however, exhibit anti-ketotic properties.

Silage treated with **BIO-SIL®** inoculant undergoes homofermentative fermentation; this means all the available sugars can be converted into lactic acid until conditions around pH 4.0 are achieved. Silage containing only naturally occurring lactobacillus bacteria will have high levels of heterofermentative bacteria. Their efficiency of converting plant sugars into lactic acid is around half that of homofermentative bacteria. This slower fermentation results in a large amount of the available crop sugars being used to produce acetic acid. As a general rule, heterofermentative bacteria require 2 to 3 times as long to produce the same amount of lactic acid. As a result, the total acidity within the silage does not reach the stability level of pH 4.0.

Fresh material with a 3% sugar level will allow **BIO-SIL®** lactobacillus to produce 2% of lactic acid within the first week of fermentation. At pH 4.0 the metabolism of lactic acid bacteria will stop leading to the preservation of residual sugars in the silage. The rapid action of **BIO-SIL®** lactobacillus not only protects the sugars within the crop but also promotes good fermentation. The rapid pH drop suppresses the development of undesirable bacterial populations and limits the likelihood of a "poor" fermentation.

Producing high quality silage with BIO-SIL®

What should be considered prior to harvest?

In order to promote high intake rates of silage, the crude fibre levels of high quality grass should not exceed 24% of the dry matter total. It is therefore vital to cut grass at the correct growth stage. This is generally during the stem extension stage and before the ear emergence for most grass species. In good growing conditions crude fibre in grass can be increase by 3 to 5 g/kg per day. Therefore the window for mowing grass can be around 8 days depending on weather conditions. It is advisable to take crude fibre measurements at intervals to accurately predict the optimal cutting date. Mowing should have started once the crude fibre has reached 22% to allow time for all the crop to be cut below the 24% limit. In the UK agronomists can assist with predicting cutting dates to meet target D-values for the silage.

Mowing grass

It is important to wait until the dew has dried from the grass. Standing grass will dry much more quickly than grass on the ground. Setting the correct height of cut is very important. Cutting too low will not only risk contamination of the silage but will also lead to delayed re-growth. The aim should be to leave at least one leaf on each plant so height should be in the 6 – 8cm range. In grass crops with little or no clover, then appropriate crop conditioning should be used. For crops with high legume content, then conditioning needs to be more gentle to avoid crop losses.

The ability of the crop to make good silage depends on a number of chemical, biological and physical characteristics. Of all the physical properties, the most important is dry matter percentage but osmotic pressure, chop length and compaction are also important. Of the chemical properties, the sugar content and the crop buffering capacity are the most important. The exact time of mowing should be dictated by the crop dry matter and the sugar percentage.

It is impossible to reliably predict the silage fermentation based on the ratio of sugar to buffering capacity for the crop. The silage pH will also depend on the crop dry matter percentage as this also will also have a large effect on the fermentation. For example, a natural fermentation with 35% dry matter material will prevent butyric fermentation once pH drops below 4.6. As the dry matter percentage drops, then the pH required to achieve stable, butyric free fermentation also drops. It is therefore important to wilt the cut crop in order to achieve the target DM%. This process also concentrates the available sugars for fermentation as can be seen in the table.

The effect of drying on sugar content.

Field conditions	Dry matter, %	Sugar, %
At the time of mowing	14	1,6
After 6-10 hours of drying	23	2,4
Optimal:		
16-18 hours of drying	33	3,2
24-30 hours of drying	38	3,9
Drying for 5-7 days	20	0,8
	38	2,8

It is important to achieve the target DM in as short a time as possible. Sugar percentage quickly rises after cutting to 3.9-4.0% which is sufficient to produce good levels of lactic acid. After being cut for 24-30 hrs the sugar percentage in the crop begins to drop. In extended periods of wilting this can result in forage that is extremely difficult, or impossible to ensile correctly. In some cases it is necessary to add additional sugars (in the form of molasses) to the crop. The energy value of these sugars are largely preserved within the silage as it is converted into lactic acid. Overall losses may be in the range of 0.2-1.5% of the gross energy. In contrast the energy lost by a butyric fermentation may be over 18%. Some of the sugar will also remain in a lactic acid fermentation – silage with a 5% residual sugar DM level is considered desirable and palatable.

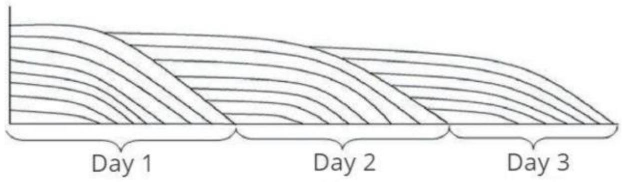
Favourable weather conditions will give rapid wilting and maintain the optimum dry matter levels above 30%. Chop length should be reduced in high dry matter crops to around 20mm to achieve good compaction. Chop lengths of up to 60mm may be used when molasses is added to the silage.

Wet weather conditions prevent dry matter rising to the target in a short time. To avoid high in field losses, silage may have to be ensiled with dry matter below 26%. In these conditions chop length should be increased to around 80mm. Losses should then only occur with DM below 26%.

Filling and compacting the clamp.

- Fill the clamp quickly and if harvest is not completed in one day then the clamp should be covered at night.
- Thorough compaction of each layer is required, compaction tractor speed should not exceed 4km/h. Once filled the silo should be compacted for at least 20 minutes but not more than 1 hour. Traffic after this time will expel CO_2 that's building up within the silage. This CO_2 is very effective at killing yeasts. The upper layer of silage should be chopped at 8-10mm to ensure good close compaction.
- After compaction, the clamp must be covered with an air-tight seal and the covers secured with tyres, bags or tiles.

Scheme of filling:



The addition of lactobacillus bacteria is effective:

- for ensiling fresh grass with high protein content 21% - 23%;
- for ensiling grass crops with high clover content;
- for ensiling lucerne (alfalfa) with the addition of molasses;
- for ensiling grass silage exposed to rainfall during wilting;
- for ensiling silage that's been subjected to frost damage.

The addition of lactobacillus bacteria is ineffective:

- for ensiling grass crops that have not been wilted;
- for ensiling grass silage with dry matter above 50%;
- for ensiling grass that been repeatedly exposed to rainfall and

- for grasses that have turned brown;
- for ensiling grass that is past the optimal maturity stage once seed heads are formed;.
- for ensiling fresh lucerne without additional sugar additives such as molasses that have been wilting for in excess of 48 hrs.

Hidden benefits to profitability

The addition of highly effective homofermentative lactobacillus bacteria improves fermentation, reduces losses and increases forage digestibility. Feeding this type of silage to dairy cattle ensures high forage dry matter intakes which in turn provides high productivity. For example silage with the high energy density and good fermentation can increase intake by as much as 3kgDM/cow/day when compared to a silage with same energy density but a poor fermentation.This difference can result in a 6kg per day milk yield increase.
Using homofermentative lactobacillus bacteria can increase the energy density of the silage. These benefits in silage quality are also long term as body condition and (as a result) herd fertility can also improve over time. The use of **BIO-SIL®** is a highly profitable investment in forage.

Why BIO-SIL®?

Silage inoculants can be divided into two distinct types, those that initiate fermentation by accelerating the production of lactic acid (homofermentative lactobacillus bacteria) such as **BIO-SIL®** and those that improve aerobic stability of silage (heterofermentative lactobacillus bacteria). In untreated forage crops heterofermentative bacteria outnumber the homofermentative strain many times over. Therefore during the initial period of fermentation, even with the addition of **BIO-SIL®** , acetic acid will always be produced and this can aid aerobic stability of the silage.
The following examples can help in the correct choice of product.

Case 1 - Wet silage of grass or legumes with dry matter below 30%
Only homofermentative lactobacillus inoculants such as **BIO-SIL®** will be useful in quickly reducing pH and suppressing excessive acetic and butyric acid fermentation.

Case 2 – Cows house year round
For silage clamps that will only be fed during the winter months, it is suitable to treat this silage with homofermentative inoculates such as **BIO-SIL®** . For clamps used during warmer summer months a heterofermentative inoculant or **BIO-SIL®** with added Potassium Sorbate should be considered for increased aerobic stability.

Case 3 – Silage that will be moved and re-clamped
Heterofermentative inoculant or **BIO-SIL®** with added Potassium Sorbate should be considered for increased aerobic stability.

Case 4 – Silage ground that has received heavy manure or slurry fertilizer application.
High slurry and organic manure applications can lead to reduced levels of naturally occurring lactobacillus bacteria. Silage should be treated with homofermentative inoculates such as **BIO-SIL®** to ensure production of high quality silage.

Summary

In 80% of ALL cases, the naturally occurring lactobacillus bacteria are insufficient to achieve a rapid drop in pH (in less than 3 days). The use of **BIO-SIL®** homofermentative inoculate is vital to guarantee the production of excellent quality silage.

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