BIOMIN
Silage Management Program

Naturally ahead

Biomin®

Content

BIOMIN SILAGE MANAGEMENT PROGRAM

I - INTRODUCTION

Ensiling is a key process to preserve forage and crops for cost-effective animal feed. Getting the ensiling process right is critical to maximize feed value and ensure good animal productivity and health. Excellent silage requires a high level of management and the right tools. The BIOMIN Silage Management Program guides you through this complex process to help get the best results.

We developed the Biomin® Biostabil silage inoculant line based on extensive research on each of the major silage types. BIOMIN owns the bacteria strains and has its own production facilities for fermentation. Many laboratory and field trials have confirmed the superior effectiveness of our silage inoculants for different forages and crops in a range of conditions.

With the aim of offering a complete solution package, the BIOMIN Silage Management Program was created. It consists of a series of simple techniques to determine the silage quality under field conditions. The program includes sensory evaluation, and measures dry matter content, particle length, pH value and temperature. The information is used to monitor, evaluate and contribute to the continual improvement of silage management.

We wish you successful ensiling!

BIOMIN Product Line Microbials

II - BIOMIN SILAGE PROGRAM

1 - SILAGE EVALUATION KIT

In the following pages, simple methods of evaluating the silage quality will be presented. As professional silage experts and producers, we need some equipment for that purpose.

Table 1 *- Contents of a silage evaluation kit used to determine the important parameters in silage assessment*

Parameter	Silage Kit		
	Basic	**Advanced**	**Expert**
Sampling	grab, shovel	gloves, grab or shovel or long corer	gloves, bags, grab or shovel or long corer
Sensory characteristics	–	silage aroma case	silage aroma case, "artificial nose" sensor
Temperature	regular thermometer or by touch	infra red thermometer	thermal camera
pH value	pH strips	pH strips	portable pH meter
Particle length	visually assessed	Penn State Separator	Penn State Separator
Dry matter determination	wring test	microwave, kitchen scales	portable Near Infrared Spectrometry (NIRS)
Nutrient and energy content	–	from laboratory	
Compacting	sensory	long corer, scale	long corer, scale
Miscellaneous	calculator, tape, measure, beakers, extra bags, scotch tape		

2 - SAMPLING

To determine the quality of silage it is important to take a representative sample of the test material. Combining a number of sub-samples will provide a representative sample.

Sample after at least 3 – 4 weeks of fermentation. Using a long corer *(Photo 1* and *2),* take six samples (from different sampling points) of 25 cm cores down through the stack. Discard the top portion if there is any sign of deterioration.

When taking the samples by grab, shovel or hand, take at least six samples of about 400 – 500 grams each from different parts of the stack/pit, again discarding the surface portion if there is any sign of deterioration.

Mix all six subsamples together well, and place approximately 2 – 3 kg of the pooled sample into the sample bag. Do not take samples from areas that have been uncovered for more than ½ day.

When sampling bales, take samples from the center of the representative number of bales e.g. sample every 5^{th} – 10^{th} bale, depending on the number of bales.

Always seal the plastic cover on the bale or pit after sampling.

It is important to sample each silage batch separately. After sampling, squeeze the air out of the bag (the best method is to use a vacuum seal), seal it tightly, label the bag clearly. If you plan to send the samples immediately, which is strongly recommended, place into a refrigerator for 2 – 3 hours. If not, store the samples in a freezer until sending for analysis.

Send the sample(s) to the laboratory as soon as possible!

Photo 1. *Long corer for silage sampling*

Photo 2. *Long corer used horizontally*

3 – SENSORY CHARACTERISTICS

It is possible to evaluate silage quality using the sensory organs. They can provide a lot of information if the evaluator is well-trained. The main sensory characteristics are color *(Table 2),* smell *(Table 3)* and texture.

Table 2 - *Different colors in the silage and possible indications*

Color	Possible causes	Corrective actions
Yellow	High levels of nitrates, may appear in patches	Test for nitrates before feeding
Dark green	High butyric acid production	Check butyric acid level, consider decreasing inclusion rate
Brown	Overheated/protein damage	Ensure a well-balanced final ration with attention to energy and protein
Black	Severely overheated or soil contaminated	Decrease the inclusion rate if feed intake decreases Mix with other palatable feedstuffs
Grey/white	Moldy	Discard affected areas with a safety margin of at least 10 cm from visible mold. Compost or bury the moldy silage

Table 3 - *Different smells in the silage and possible indications*

Silage aroma	Possible causes	Corrective actions
Sweet	Good fermentation/ lactic acid	Check aerobic stability Guarantee a good advance in the silo
Vinegar	Mixed fermentation/ acetic acid	Control feed intake Consider mixing with other highly palatable feedstuffs
Fruity	Mixed fermentation/ yeast activity	Increase feed-out rate Treatment of the layer in contact with the air with a chemical product (organic acids) if needed
Fecal	*Escherichia coli* contamination	Check feed intake Check health status Consider alternative feed source
Vomit	Secondary fermentation/butyric acid	Control feed intake Consider mixing with other highly palatable feedstuffs
Sharp	Excess acidity (pH value)	Add buffer substances when mixed in the TMR

Talking about smells without anything to refer to is sometimes difficult. BIOMIN has produced a silage aroma case containing solutions of butyric and acetic acid, as well as ethanol in different concentrations *(Photos 3a and b).*

While assessing the smell, also examine the structure visually. The plant materials should maintain their structure. The bigger the structure changes, the worse the silage.

Photo 3a. *Silage aroma case*

BIOMIN Silage Assessment (SA)
Organoleptic evaluation
Smell: Acetic acid 1%

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Photo 3b. *Example of a label for the silage aroma recipients*

4 – TEMPERATURE

Heat in silage always means nutrient and energy losses. Heat in the aerobic phase of the ensiling process must be differentiated from heat in the feed-out phase. After harvest, in the aerobic phase, many aerobic microorganisms and the plant enzymes are still active. They convert nutrients into the end products of carbon dioxide, water and heat (exothermic reactions). These processes can be controlled by harvesting at the correct maturity, chopping to the correct particle length, good compacting, good timely sealing of the silo (within 24 hours of harvest) and use of an effective silage inoculant with homofermentative bacteria.

A second heating ("silage fever") can occur in the case of aerobic deterioration, caused mainly by yeasts. Good compacting and the use of an effective silage inoculant containing heterofermentative bacteria can prevent silage fever.

Once the farmer measures an increase in silage temperature, preventive actions are needed e.g. speeding the advance of the silo, treatment with chemical products and a clean cut of the silage. The temperature can be measured by touch, with normal or infrared thermometers *(Photos 4 and 5, respectively)* or with a thermal camera *(Photo 6a)* or temperature measuring rod *(Photo 6b). Photos 7a – d* show the use of a thermal camera and derived images.

Photo 4. *Digital thermometer*

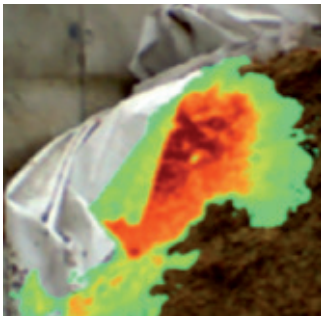
Photo 5. *Infrared thermometer*

Photo 6a. *Thermal camera*

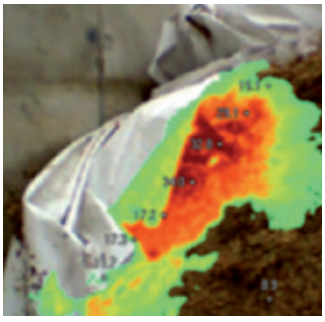
6b. *Temperature measuring rod*

Photo 7a. *Using a thermal camera under field conditions*

7b. *Normal photos*



7c. *Thermal image*



7d. *Thermal image with temperature profile*

5 – MEASURING pH VALUE

The decrease in the silage pH value is crucial for preventing the growth of undesirable microorganisms in the silage, and minimizing dry matter, nutrient and energy losses. The dry matter content of the ensiled forage material plays an important role for creating stable silages.

Steps for measuring the pH value:

1. Take at least six samples from six different places of fresh silage (avoid prolonged contact with air)
2. Weigh 100 g of each sample and put into a beaker
3. Add 100 ml of distilled water
4. Mix the water with the sample
5. Let the samples rest for 15 – 30 minutes

After the rest period, the pH value can be measured using a pH strip or a pH meter:

With a pH strip *(Photos 8a – c):*

6. Dip the test strip into the solution, in the direction of the arrow, for roughly three seconds
7. Compare the indicator zone (unprinted area) to the color scales and read off the printed pH value. Holding the strip up to a light source will make the pH determination easier.

With a pH meter *(Photos 9a and b):*

6. Put a well-calibrated pH meter into the solution and measure the pH value.

8a.

8b.

8c.

Photos 8a – c. *pH value determination using pH strips*

9a.

9b.

Photos 9a and b. *Measuring the pH value with a pH meter*

Under practical conditions, in relatively wet silages (below 40 % dry matter) and for a quick orientation, the pH strip can be put in the middle of a sample and pressed. The result can be read immediately on the color scale *(Photo 8c).* Once the pH value is determined, the success of the acidification can be assessed using the following *Table 4.*

Table 4 - *Evaluation of the acidification according to the dry matter content of corn silage*

Dry matter content of the silage (%)					
< 30		30 – 35		> 35	
pH	Evaluation	pH	Evaluation	pH	Evaluation
< 3.9	very good	< 4.0	very good	< 4.3	very good

6 – PARTICLE LENGTH

Optimum particle length is a balance between silage quality and functionality in the digestive tract of the ruminants. A longer particle length guarantees forage fiber for increased chewing activity, saliva flow and stabilization of the rumen fermentation. The lack of so called "effective fiber" with short fiber lengths decreases chewing and rumen activity but results in a better compacting of the silage.

A very practical way to measure particle length is by using the Penn State Separator *(Photos 10a – d),* which consists of three or four stacked boxes with holes.

Stack the plastic separator boxes on top of each other in the following order: pan with no holes at the bottom, then screens in order of hole size with the largest holes at the top.

Place approximately 500 – 1000 g of forage or total mixed ration (TMR) in the upper sieve. On a flat surface, shake the sieves in one direction five times. There should be no vertical motion during shaking. This process should be repeated eight times with the sieves rotated a 1/4 turn after each set of five shakes. After the first 40 shakes check for any clumps that may be on the top screen (these need to be broken up). Weigh the material in the sieves and in the bottom pan separately. For evaluating the results, the percentage in each sieve and bottom pan must be calculated. Optimal values are presented in *Table 5.*

Table 5 - *Optimal particle lengths in different fodders*
(Reference: Penn State Extension, 2017, https://extension.psu.edu/penn-state-particle-separator)

Sieve (diameter of the holes)	**Percentage (%)**		
	Corn silage	**Haylage**	**TMR**
Upper sieve (19 mm)	3 – 8	2 – 20	2 – 8
Middle sieve (8 mm)	45 – 65	45 – 75	30 – 50
Lower sieve (4 mm)	20 – 30	30 – 40	10 – 20
Bottom pan	< 10	< 10	30 – 40

Photo 10a. *The Penn State Separator*

10b. *Filling the upper sieve*

10c. *Shaking the Penn State Separator*

10d. *Weighing the remaining material in each sieve*

7 – DRY MATTER DETERMINATION

Dry matter (DM) is the main criterion for determining when to harvest a crop for ensiling; and also an important criterion of the silage quality. Dry matter is the remaining part of a feedstuff after removing the moisture. The optimal DM contents at harvest are shown in *Table 6*.

Table 6 - *Optimal dry matter values for ensiling according to the crop used and technology*

Crop	Optimal dry matter content (%)
Grass	30 – 40
Corn	30 – 40
Alfalfa	35 – 45
High moisture corn grain	Around 65%

Squeeze test:

A simple method in which the dry matter will be estimated, is to press a sample with the hands. The precision of this method is about ± 5%. For wet silages (dry matter below 30%) a silage sample in the form of a simple ball may be used.

The estimation of the dry matter in the silage is done by pressing and subsequent visual evaluation of the samples *(Table 7)*.

Dry matter determination with a microwave:

A very practical determination of the DM content can be made using a microwave. For this method, scales and a calculator are also needed. The method is described below. The whole procedure is also graphically documented in the *Photos 11a – c* and *12a – c.*

- take five representative samples from different places of the field/ silage pit
- mix and cut the samples finely. Take an approx. 200 g representative sample of the material
- Place the material in the microwave. It is important to also place a glass of water in the microwave, so the water can absorb the energy when the feed is dry.

Table 7 - *Estimation of the dry matter content with the squeeze test*

Estimated dry matter content (%)	Result of the squeeze test
< 20	Plant juice leaving after slight hand pressing
25	Plant juice leaving after stronger hand pressing
30	Plant juice left between fingers, the hands will be wet
35	No plant juice left between fingers, however hands will be wet
40	Hands will still shine after pressing
45	Hands left with a slight damp feeling after pressing
> 45	Hands remain dry after pressing

- use max. 200 Watt power with intervals of up to two minutes each, until a constant weight of the material is achieved.
- for DM contents < 35%, this will take approximately 30 minutes, for DM contents around 50%, ~ 15 minutes

The DM content (in %) can be calculated as the quotient of the end weight and the initial weight, multiplied by 100.

An example of the weight changes of the samples and the calculated DMs are shown in *Figure 1*.

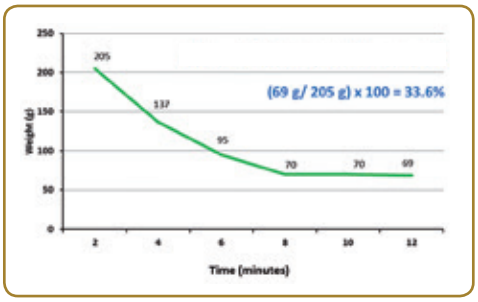


Figure 1. *Weight changes after different drying times. Calculation of the dry matter content*

Photo 11a. *Initial weighing*

11b. *Putting the sample in the microwave*

11c. *Weighing after a certain period of time*

Photo 12a. *Original material*

12b. *Material still containing 50% of the original moisture*

12c. *Dried material*

8 – COMPACTING

Compacting has a major influence on silage quality. High compaction means high density, which reduces air content and penetration of the silage. This has several advantages: an increase in nutrient and energy density in the silo, a reduction of oxidation losses, and improvement in the aerobic stability. The dry matter content and the particle length are important factors for achieving good compaction. There is a rule: the higher the dry matter, the shorter the particle length. A silage density of 700 – 800 kg of silage/m^3 should be reached.

For this purpose, it is recommended to calculate the required weight of the pressing machine, according to the crop and dry matter content. The weight of the pressing machine should correspond with the transport yield in one hour, divided by the coefficient 4 (for normal dry matter content). If the dry matter is higher, the coefficient should be lower (3 or even 2).

Example 1:

Harvested material = 50 t/hour

Dry matter content (corn) = 30% (normal)

Weight of the pressing machine = 50/4 = 12.5 ton

Example 2:

Harvested material = 50 t/hour

Dry matter content (corn) = 40% (higher)

Weight of the pressing machine = 50/3 = 16.7 ton

Several methods have been used for estimating compaction. All these methods are based on dividing the volume by the weight of the sample. A very practical method is trying to insert fingers into the silage. Under good conditions, the external silage layer should not permit any penetration into the silage *(Photo 13).*

Photo 13. *Testing silage compaction with fingers*

9 – REFERENCE VALUES FOR SILAGE QUALITY DETERMINED IN LABORATORIES

The silage quality may be expressed in different parameters. The following *Tables 8, 9 and 10* are based on data produced by the German Association for Agriculture (DLG, in German), other sources and own investigations. All values may be used as references to interpret laboratory analysis.

Table 8 - *Nutrient and energy content in silages*

Qualitative parameters	Unit	Reference value	
		Grass	Corn
Dry matter (DM)	%	30 – 40	28 – 35
DM density	kg/m³	600 – 800	
Crude protein	% in DM	< 17	< 9
Fiber content	% in DM	22 – 25	17 – 20
Ash content	% in DM	< 10	< 4.5
Net energy lactation	MJ NEL/kg DM	6.0 – 6.4	> 6.5
Organic matter digestibility	%	> 70	

Table 9 - *Silage quality in fermentation*
(Reference: Kung and Shaver, 2001, https://fyi.uwex.edu/forage/files/2014/01/Fermentation.pdf)

Qualitative parameters	Unit	Reference value	
		Grass	Corn
Dry matter (DM)	%	30 – 35	30 – 40
pH	-	4.3 – 4.7	3.7 – 4.2
Lactic acid	% in DM	6 – 10	4 – 7
Acetic acid	% in DM	1 – 3	1 – 3
Propionic acid	% in DM	< 0.1	< 0.1
Butyric acid	% in DM	0.5 – 1.0	0
Ethanol	% in DM	0.5 – 1.0	1 – 3
Amonia-N (% of CP)	% in DM	8 – 12	5 – 7

Table 10 - *Microbiological silage quality (References. a: McDonald et al. (1991); b: VDLUFA Methodenbuch III (2005); c: Penn State Extension; https://extension.psu.edu/mold-and-mycotoxin-problems-in-livestock-feeding; d: Wang et al. (2016)*

Microorganism	Value (CFU/g)	
	normal	elevated
Yeast	< 100 000[a]	> 1 000 000[b]
Molds	< 5 000[b]	> 1 000 000[c]
Aerobic mesophile bacteria	< 100 000 000[d]	> 100 000 000[d]

10 – PROBLEMS IN SILAGES, CAUSES AND CORRECTIVE ACTIONS

Being familiar with the potential problems of silage production and their causes is key to taking timely corrective actions at the harvest of green forage, or at the opening of a silo.

In *Table 11,* common problems in silage quality are listed, as well as their possible causes and corrective actions.

Table 11 - *Problems, possible causes and corrective actions during harvest*

Problems	Possible causes	Corrective actions
Low dry matter (< 25 %)	The crop is not yet in the right maturity stage Bad weather conditions Can be normal in some by-products (citrus pulp, brewer's grain)	Wait until the crop reaches optimal dry matter content Wilting Use chemical products based on sodium nitrite and/or formic acid Add absorbent materials (e.g. haw, straw)
High ash content (soil contamination)	Low cut height Bad hygiene during the harvest	Use chemical products based on sodium nitrite and/or formic acid Check the cut height (corn, 20 – 30 cm; grass/alfalfa, 6 – 10 cm) Avoid soil contamination
High dry matter (> 50%)	Very variable, in most cases due to: Unexpected weather conditions Low level of priority in the harvest	Quick decision making: silage or hay in case of grass/alfalfa? If silage, ensile immediately Shorter particle length than usual Increase the compacting time and the weight of the compacting machines Place heavier weights on the silage Place thin material layers (< 20 cm) in the silo Use water with molasses, increase the moisture and the availability of energy for the lactic acid bacteria, and improve the compacting Use chemical products containing propionic acid
Insufficiently heavy pressing machinery	Economical factors	Increasing the weight of the compacting machine by filling the tires with water, or make use of metal or concrete blocks on the machine to increase the weight An alternative can be to decrease the harvesting speed

Problems	Possible causes	Corrective actions
Silo filling time over 3 days	Insufficient machinery Extremely big silos Unexpected events (machines breaking, bad weather conditions, etc.)	Cover the silage every day after work with an air tight silo sheet If the silo configuration makes it possible, divide the silo into two halves for doubling the speed of silo filling
High pH value/ low acidity	High energy content and buffer capacity Insufficient lactic acid amount due to other fermentations (butyric or acetic acid, or ethanol) Aerobic instability (lactic acid converted to ethanol)	Use a silage inoculant with adequate homofermentative bacteria for better anaerobic fermentation for high protein silages Include extra energy sources (e.g. molasses, if feasible) or treat the layer in contact with air with chemical products Use silage inoculants with heterofermentative lactic acid bacteria in the future to prevent aerobic instabilities
Silage aerobic instability	Insufficient compacting Low feedout rate No heterolactic silage inoculant used Bad airtight sealing	Check compacting, as well as particle length and dry matter, and decision making for the next silage season Use silage inoculants with heterofermentative lactic acid bacteria in the future Check the dimensions of the silo and the needs of the farm. If needed, divide the silo into two halves or evaluate the possibility of the use of certain amount of silage (increase the number of animals, feed other categories, cooperate with neighbors) Check the ensiling time (> 3 – 4 weeks to favor the acetic acid fermentation) Increase the feed-out rate Treat the layer in contact with air with a chemical product, if needed re-ensiling in extreme cases using a chemical product

11 – MOLDS AND MYCOTOXINS IN SILAGES:

Some of the most common molds in silages are listed in *Table 12,* as well as the mycotoxins they produce.

The appearance of some molds common on silages are shown in *Photos 14 to 16.*

Photo 14.
Monascus ruber

Photo 15.
Aspergillus fumigatus

Photo 16.
Fusarium graminearum

Table 12 - *Silage fungi and their mycotoxins*

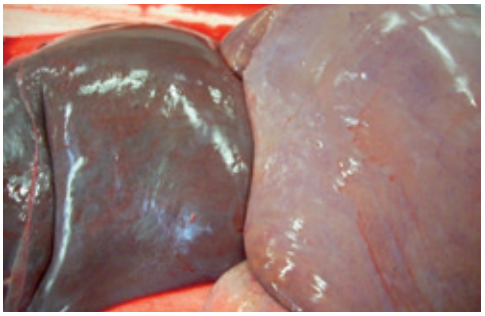
Mycotoxin-producing fungi	Appearance	Mycotoxins
Aspergillus	Yellow – green, white or grey Can also be black *(e.g. Aspergillus niger)*	Aflatoxins (B_1, B_2, G_1, G_2), ochratoxin (A), patulin, cyclopiazonic acid (CPA), gliotoxin depending on species
Claviceps	Dark brown, black sclerotia in seed shape	Ergot alkaloids: Clavines (argroclavine), lysergic acids, lysergic acid amids (ergin), ergopeptines (ergotamine, ergovaline)
Fusarium	White, cream or pink	Fumonisins (B_1, B_2, B_3) type A trichothecenes: T-2 toxin, HT-2 toxin, diacetoxyscirpenol type B trichothecenes: nivalenol, deoxynivalenol, fusarenon-X Zearalenone
Penicillium	White – green or blue	Ochratoxin (A), citrinin, roquefortine, cyclopiazonic acid (CPA), patulin depending on species
Neotyphodium and relatives	Not visible without a microscope. Present within grass shoots	Tall fescue and ryegrass toxins: Ergot alkaloids (e.g. ergovaline), lolines, peramine, lolitrem B

Photo 17a. *Mastitis (trichothecenes)*

17b. *Lameness (trichothecenes, ergot alkaloids)*

17c. *Metritis (trichothecenes)*

The following photos from *17a – e* show some of the main effects of mycotoxins on cattle fed with contaminated silage.



17d. *Fatty liver (aflatoxins)*

17e. *Acidosis (trichothecenes)*

III BIOMIN SILAGE MANAGEMENT PROGRAM IN ACTION

The following section contains practical examples of putting the Biomin Silage Management Program into action around the world.

1 – EL SALVADOR AND CZECH REPUBLIC

After a visit to a Central American farm and also to Central European farms, an excellent practice was discovered: after covering the silo with adequate plastic sheets, the producers used bricks and cement blocks respectively to keep the silo airtight *(Photos 18a and b).*

In spite of the huge differences in production scale (silo capacity of approx. 200 and 5 000 ton for El Salvador and Czech Republic, respectively) and climate conditions, the idea and the aim is the same: minimize or even eliminate the possibility of air getting into the silo.

Photo 18a. *Silo covered with plastics sheets and bricks in El Salvador*

Photo 18b. *Silo covered with plastics sheets and cement blocks in Czech Republic*

2 – AUSTRALIA

Non-covered silages suffer from high losses in dry matter, nutrients and energy. This Australian silage was not covered and furthermore had drainage problems *(Photos 19a and b)*.

The upper layer was totally damaged and useless. It was recommended to discard it. A simple calculation of the losses in fresh matter was carried out as shown:

- Cost/t: 70 USD
- Cost/m^2 cover: 1.50 USD
- Area: 5 x 10 m = 50 m^2
- Depth: 0.20 m
- Volume: 10 m^3
- Layer to discard: 10 m^3 x 0.65 t/m^3 = 6.5 ton
- **Economical losses: 6.5 ton x 70 USD/ton = 455 USD**
- **Cost for covering 50 m^2: 75 USD**

Difference: 380 USD

The calculation above is only taking into account the fresh matter losses. To calculate the total losses in performance, due to insufficient covering, mycotoxin contamination also needs to be considered.

Photo 19a. *Silo not covered and with drainage problems*

Photo 19b. *The upper layer must be discarded*

3 – AUSTRIA AND USA

A common problem for some silage producers is incorrectly estimating the storage capacity (underestimation of the needed capacity, lack of space for fulfilling the needs during the year). Creativeness is required to overcome problems like those shown in *Photos 20a and b* below.

These silos are difficult to manage. As well as aerobic instability and enormous losses, they are dangerous for humans in case of collapse.

Photo 20a. *Overloaded silo in an Austrian biogas plant*

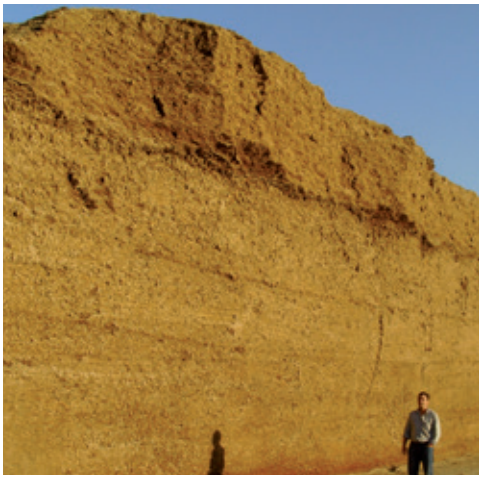


Photo 20b. *Oversized silo in USA (courtesy of Mr. Telmo Rodrigues)*

4 – PORTUGAL

Despite *Photos 21a and b* having been taken a couple of kilometers from one another, the differences are very marked. A clean cut plays an essential role in the prevention of aerobic instability. As shown in the photos, the silages also differ very strongly in compaction.

Photo 21a. *Bad management of the silage layer in contact with the air*

Photo 21b. *Excellent management of the silage during the feed out phase (right)*

5 – CHINA

Photo 22 shows a corn silage with a long particle length. The corn kernels have not been broken, which will result in poor digestibility. The corn will pass through the digestive tract without being used by the animal.

Photo 22. *Long particle length and unbroken kernels in corn silage*

IV BIOMIN SILAGE ASSESSMENT REPORT: AN EXAMPLE

After each farm visit, or each evaluation of silage quality at the booth in exhibitions, BIOMIN provides a final report for its customers. This feedback is used to make decisions for improving the productivity of the animals and the profitability of the farm.

An example of a final report is shown here:

BIOMIN Silage Assessment Report

Country: Uruguay
Farm: XY
Date: 17.08.2010
Farm technician: Ing. Jorge

Type of silo: bunker
Type of silage: corn
Silage inoculant: yes
Capacity (t): 150 x 28 x approx. 3 m = 12 600 m^3
8 820 tons of corn silage (density 700 kg/m^3)

Parameters:

I – Organoleptic characteristics:

a) Color: not changed, slightly yellow or brown
b) Texture: leaves and stalk well defined
c) Smell: in some areas, butyric smell or musty, in others ethanol smell

II – Particle length:

Evaluated organoleptically. The particle length is better than in previous visits. Nevertheless, it still has to be improved *(Photo Ia).*

For corn whole plant silage, the recommendation is to use a particle length of 12 to 18 mm.

A major aim is to crush the grain in order to make the nutrients available for optimal use by the animal *(Photo Ib)*.

The cut height should be adapted to harvest a higher quality material. *The cut height for silage corn should not be lower than 20 – 30 cm.*

A low cut height at harvest increases the quantity of harvested material but decreases the quality of:

a) the silage, since the stalks are difficult to compact and
b) the feed because stalk will be digested slower, decreasing feed intake and therefore animal productivity (*Photos Ia, b, c*).

Photo Ia. *Long particle length*

Photo Ib. *Big pieces of corncob*

Photo Ic. *Long pieces of stalks*

III – Compacting:

In this case compacting was good, however, in some places the material was not compacted enough *(Photo IIa).* This leads to the formation of "air pockets" (*Photos IIb, c*). Their consequence will be discussed below.

Photo IIa. *Testing compacting*

Photo IIb. *Air pocket*

Photo IIc. *Moldy area*

IV – Time of silo filling:

Silo filling takes more than one week. Optimal silo filling time is one day. It should not be more than three days. Recommend to increase the capacity of the harvesters, looking for cooperation with contractors.

V – Covering:

The upper silage layer was considerably spoiled (approx. 10 – 20 cm, *Photo IIIa*), especially on the borders near silo walls *(Photo IIIb).* A simple calculation estimates the quantitative losses as approx. 270 tons in each silo [(150 x 28 x 0.10 m) x 0.65 tons/m^3].

Strongly recommended to cover the silo with adequate sheets and proper weights (tyres, soil or sand bags).

Photo IIIa. *Deterioration of the upper layer*

Photo IIIb. *Deterioration at the silo walls*

VI – Aerobic stability:

Thermal images of the silage were taken *(Photo IVa).* On *Photo IVb* temperature differences are shown (from 18.8 to 24.4 °C). It corroborates that the silage is spoiling or having aerobic stability problems.

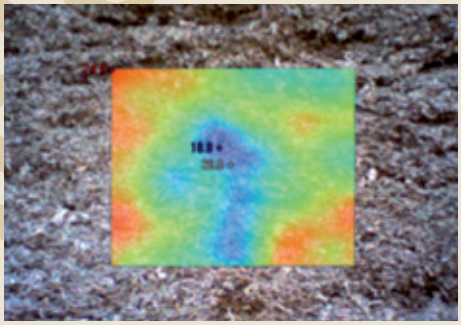


Photo IVa. *Thermal image of the silage*

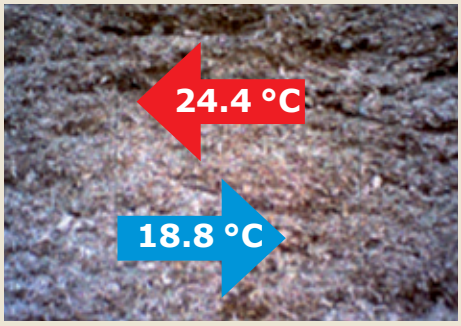


Photo IVb. *Differences in silage temperature*

Exothermic reactions are mainly the result of the yeast action. They:

a) degrade the silage nutrients causing enormous nutrient and energy losses,
b) reduce the palatability of feed due to the formation of ethanol

Therefore, it is recommended to:

1- Pay close attention to the compacting
2- Increase the advance in the silo (see point VII), eventually dividing the silo into two halves
3- Use a silage inoculant that contains heterofermentative bacteria, supporting aerobic stability

VII – Advance/progression in the silo:

Table 1 *- Need of daily silage extraction to minimize losses due to aerobic instability*

Parameter	Unit	Season	
		Summer	Winter
Recommended advance in the silo *(minimum)*	m	0.50	0.25
Expected density	kg/ m^3	700	
Silage extraction per day *(minimum)**	ton/ day	29.4	14.7

** Need of daily silage extraction = [recommended advance per season x width x height (m) x density (kg/m^3)]/ 1 000*

The advance in the silo should be approx. 0.50 and 0.25 m/day in summer and winter respectively.

This advance in the silo would correspond with a silage extraction as shown in *Table 1.*

VIII – pH value:

Measure the pH of the silage using a pH strip *(Photos Va,b,c).* The average pH values from three different places was 3.8, indicating the acidification was good. This is common for corn whole plant silage.

Photo Va. *Put in pH strip into the sample*

Photo Vb. *Press the pH strip into the silage*

Photo Vc. *Read the pH value from the pH strip*

IX – Cut of the silage:

The cut in the external layer of the silage is not clean *(Photo VI).* It permits air penetration and the proliferation of yeast (aerobic instability) and molds (contamination with mycotoxins).

Photo VI. *Irregular cut of the external silage layer*

X – Contamination with molds:

Several places were contaminated with fungi, not only in the upper layer *(Photo VIIa)* but also inside the ensiled material *(Photo VIIb).* This leads again to air pockets in the silage.

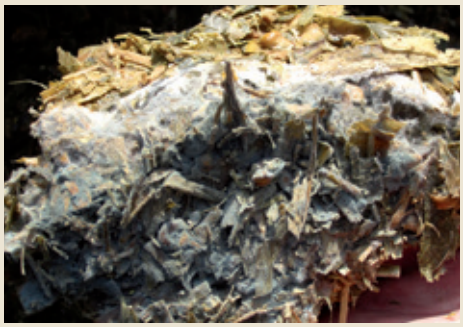


Photo VIIa. *Contaminated upper silage layer*

Photo VIIb. *Formation of mold colonies*

Samples of the silage were sent to an external laboratory (QUANTAS Analytics, Austria). The mold contamination reached 6 x 10^7 CFU/g of silage. From this total contamination, 3 x 10^7 and 2 x 10^7 CFU/g of silage corresponded to *Aspergillus fumigatus* and *Lichtheimia* (formerly *Absidia ramosa*) respectively. These molds can produce mycotoxins which cause disease *(A. fumigatus),* and even abortions in cows *(L. ramosa).*

A contamination of 4 000 CFU/g in silage is still considered as "normal". The silage sample in question showed a contamination 15 000 times higher.

The yeast contamination was 7 x 10^6 CFU/g of silage, ten times higher than the value considered as the limit for causing aerobic instability (1 000 000 CFU/g).

See recommendations in point VI for improving aerobic stability.

XI – Contamination with mycotoxins:

The samples were contaminated with fumonisin B_1 and fumonisin B_2 (256 and 90 ppb respectively, method LC-MS, detection limit 25 ppb). These toxins are normally produced by field Fusarium fungi. Fumonisins cause pulmonary edema, equine leukoencephalomalacia, nephro- and hepatotoxicity and immune suppression.

V CONCLUSIONS

The BIOMIN Silage Management Program assists in decision making and improvement of the ensiling process. With this series of steps, improved feed quality can be achieved, reducing spoilage and maximizing farm productivity.

Contact BIOMIN to find out more about the Biomin® BioStabil silage inoculant product line and access the full range of educational tools, technical support and service that the BIOMIN team provides.

Notes

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BIOMIN has implemented the following standards:

HACCP APPROVED · ISO 9001 CERTIFIED · ISO 14040 Approved Life Cycle Assessment · ISO 14001 CERTIFIED · GMP+ · FAMIQS

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