Biomin® BioStabil

Preserves the energy in your silage!

The BIOMIN SILAGE ASSESSMENT

Naturally ahead

Biomin®

Content

The BIOMIN SILAGE ASSESSMENT

I - INTRODUCTION

Nowadays the market for feed additives is very well diversified and competitive. Sometimes it is not enough to have good products. The farmer expects to have an additional value in terms of services, consultancy, etc. in which the product itself becomes just a tool inserted into a whole program to solve the very complex challenges present in the farm.

Years ago BIOMIN introduced a new product range in silage inoculants based on extensive research. BIOMIN owns the different bacteria strains and has own production facilities for fermentation. Many laboratory and field trials corroborate the high effectiveness of our silage inoculants in very different farm conditions, climates and crops.

With the aim of offering a whole solution package, the Biomin silage management program is created. It consists of a group of very simple techniques to determine the silage quality under field conditions. Silage quality parameters like organoleptic evaluation, dry matter content, particle length, pH value, temperature, etc. can already be used by our sales agents as a powerful tool for assessing the silages under field conditions.

Best wishes,
Competence Center Microbials

II - BIOMIN SILAGE ASSESSMENT

0 - SILAGE EVALUATION KIT:

In the following pages, very simple methods of evaluating the silage quality will be presented. The professional silage expert, as well as producers, need minimal equipment for that purpose. *Table 1* gives an overview about important parameters and the silage evaluation kit.

Table 1 *- The silage kits*

Parameter	Silage kit		
	basic	advanced	expert
Sampling	grab, shovel	gloves, grab or shovel or long corer	gloves, bags, grab or shovel or long corer
Organoleptic characteristics	-	silage aroma case	silage aroma case, sensorial artificial noses
Temperature	regular thermometer or sensory organs	infra red thermometer	thermo camera
pH value	pH strips	pH strips	portable pH meter
Particle length	visually	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 …		

1 - 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 give you a mean or a representative sample.

First, at least 3 – 4 weeks of fermentation should have occurred before sampling. Using a long corer *(Picture 1)*, take 6 samples of 25 cm cores down through the stack discarding the top portion if there is any sign of deterioration.

When taking the samples by grab, shovel or hand, take at least 6 samples of about 400 – 500 grams each from various parts of the stack/pit, again discarding the top portion if there is any sign of deterioration.

Mix these samples and place approximately 2 – 3 kg into the sample bag. An adequate sample bag has been designed by BIOMIN *(Picture 2).* Do not sample silage which has been uncovered for more than ½ day.

When sampling bales, take the samples from the centre of a representative number of bales. Sample every 5th – 10th bale, depending on the number of bales and variability of the crop. Always seal the plastic cover on the bale or pit after sampling.

Sample each silage separately. After sampling, squeeze the air out of the bag (the best method is to use a vacuum seal), seal it tightly, clearly label and place it in a refrigerator for 2 – 3 hours, if you plan to send the samples immediately (strongly recommended!), if not, in a freezer.

Send the sample to the laboratory as soon as possible!

Picture 1. *Long corer for silage sampling*

Picture 2. *BIOMIN sample bag*

2 - ORGANOLEPTIC CHARACTERISTICS:

It is possible to evaluate the silage quality using the sensory organs. They can provide a lot of information if the evaluating person is well trained, and can help to make right decisions in time. The main organoleptic 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	Low protein, secondary fermentation	Well balanced final ration (protein!)
Dark green	High protein if also leafy	Well balanced final ration (energy!)
Brown	Overheated/ protein damage	Well balanced final ration (energy and protein!)
Black	Severely overheated/ soil contaminated	Decrease the inclusion rate if feed intake decreases Mix with other palatable feedstuffs
Grey/ white	Mouldy	Discard the mouldy areas Compost the mouldy silage

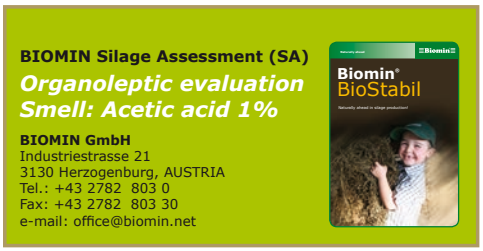
***Table 3** - Different smells in the silage and possible indications*

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

Since talking about smells without having references is too abstract, BIOMIN produced a silage aroma case containing solutions of butyric and acetic acid, as well as ethanol in different concentrations *(Picture 3)*.

The structure should be maintained. The bigger the structure changes, the worse the silage.

Picture 3. *a) Silage aroma case*



Picture 3. *b) example of a label for the silage aroma recipients*

3 - TEMPERATURE:

Heat in the silage always means nutrient and energy losses. The heat in the aerobic phase of the ensiling process must be differentiated from the heat in the feed out phase. In the aerobic phase, many aerobic microorganisms and the plant enzymes are still active in the material which is being ensiled. They convert nutrients into the end products CO_2, H_2O and heat (exothermic reactions). These processes can be controlled by good compacting, homolactic inoculation and good sealing of the silo.

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

Once the farmer measures an increase in silage temperatur, preventive actions are needed: speeding the advance in the silo, treatment with chemical products, clean cut of the silage. The temperature can be measured organoleptically (by hand), with normal *(Picture 4)* or infrared *(Picture 5)* thermometers, as well as with a thermo camera *(Picture 6a)* or a temperature measuring rod *(Picture 6b*). *Pictures 7a, b, c, d* show the use of a thermo camera and derived images.

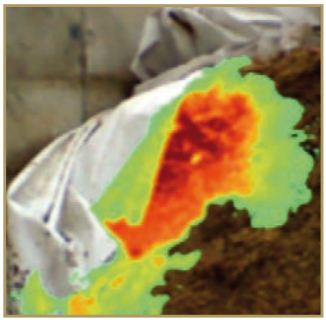
Picture 4. *Digital thermometer*

Picture 5. *Infrared thermometer*

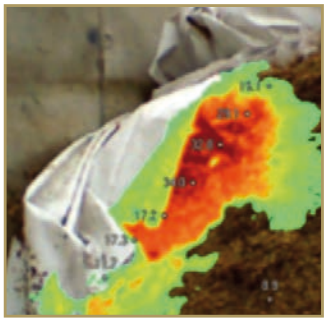
Picture 6. *a) Thermo camera b) Temperature measuring rod*

Picture 7. *a) using a thermo camera under field conditions*

b) Normal picture



c) thermo picture



d) thermo picture with temperature profile

4 - pH VALUE MEASURING:

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

Herewith a procedure on how to measure the pH value:

1. Take at least 6 samples from 6 different places of fresh silage (no contact with the air)
2. Weigh 20 g of each sample and put into a beaker
3. Add 180 ml of distilled water
4. Mix the water with the sample
5. Let the samples rest for 15 – 30 minutes

Once the H^+ ions are dispersed, the pH value can be measured using a pH strip or a pH meter:

With a pH strip *(Picture 8)***:**

6. Dip test strip into solution, in direction of arrow, for roughly 3 seconds
7. Compare indicator zone (unprinted area) to color scales and read off printed pH value. By holding strip against light, the pH determination will be easier.
8. Since you diluted the silage with water in a 1:10 ratio, the actual silage pH is 1 point lower than what you measured. e.g. when the pH strip indicates a pH of 5, the actual silage pH value is 4.

With a pH meter *(Picture 9)*:

6. Put a well calibrated pH meter into the solution and measure the pH value.
7. Since you diluted the silage with water in a 1:10 ratio, the actual silage pH is 1 point lower than what you measured. e.g. when the pH meter indicates a pH of 5, the actual silage pH value is 4.

Picture 8. *pH value determination using pH strips*

Picture 9. *Measuring the pH value with a pH meter*

Under practical conditions, in relatively wet silages (below 40 % of 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 *(Picture 23 at the page 26)*. Once the pH value is determined, an evaluation of the success in the acidification can be completed using the following *Table 4.*

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

Dry matter content of the silage (%)					
< 30		30 – 45		> 45	
pH	Evaluation	pH	Evaluation	pH	Evaluation
< 4.0	very good	< 4.5	very good	< 5.0	very good
4.0 – 4.3	good	4.5 – 4.8	good	5.0 – 5.3	good
4.3 – 4.6	bad	> 4.8	bad	> 5.3	bad
> 4.6	very bad				

5 - PARTICLE LENGTH:

The particle length is always a compromise between silage quality and functionality of 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. On the other hand, the lack of so called "effective fiber" decreases the chewing and rumen activity but results in a better compacting of the silage.

A very practical way to measure the particle length is using the Penn State Separator *(Pictures 10 a, b c and d)*, which consists of three or four boxes stacked on top of one another.

Stack the plastic separator boxes on top of each other in the following order: sieves with the larger holes (upper sieve) on top, the smaller holes (middle sieve) in the center and the pan on the bottom. Place approximately 500 – 1000 g of forage or TMR in the upper sieve. On a flat surface, shake the sieves in one direction 10 times. There should be no vertical motion during shaking. This process should be repeated 4 times with the sieves rotated 1/4 turn after each set of 10 shakes. Weigh the material on the sieves and on the bottom pan separately. For evaluating the results, the percentage in each sieve and bottom pan must be calculated. Optimal values are given in *Table 5*.

Table 5 *- Optimal particle lengths in different fodders*

Sieve (diameter of the holes)	**Percentage (%)**		
	Corn silage	**Grass silage**	**TMR**
Upper sieve (190 mm)	3 – 8	2 – 20	6 – 8
Middle sieve (80 mm)	45 – 65	45 – 75	30 – 50
Lower sieve (2 mm)	30 – 40	20 – 30	30 – 50
Bottom pan	< 5	< 5	< 20

Picture 10. *a) The Penn State Separator*

b) filling the upper sieve

c) shaking the Penn State Separator

d) weighing the remaining material in each sieve

6 - DRY MATTER DETERMINATION:

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

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

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

Squeeze test:

A very simple method, in which the dry matter will be estimated, is by pressing 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. If the dry matter is over 30 %, a silage cord should 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 utilizing a microwave. For that purpose a microwave, as well as scales and a calculator, are needed. The method is described below. The whole procedure is also graphically documented in the *Pictures 11 (a, b and c)* and *12 (a, b and c)*.

- take 5 representative samples of 5 different places of the field/ silage
- mix and cut them finely. Take approx. 200 g 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.
- use max. 200 Watt with intervals of max. 2 minutes, till constant weight of the material

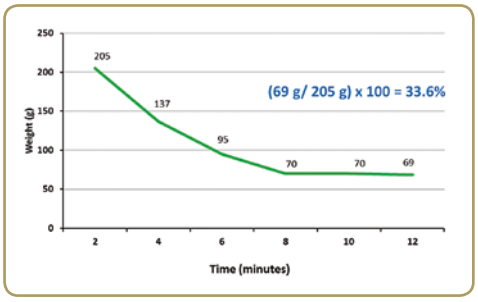
***Table 7** - Estimation of the dry matter content with the squeeze test*

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

- for DM contents < 35 %, this will take about ± 30 minutes, for DM contents about 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 is given and the DM calculated in the graphic below.



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

Picture 11.
a) initial weighing

b) putting the sample in the microwave

c) weighing after a certain period of time

Picture 12. *a) original material*

b) material still containing 50 % of the original moisture

c) dried material

7 - COMPACTING:

Compacting has a major influence on silage quality. High compacting means high density, which reduces air penetration in the silage. This has several advantages: increase in nutrient and energy density in the silo, reduction of oxidation losses, improvement in the aerobic stability. The dry matter content and the particle length are important factors for maintaining a good compacting. 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 (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 tons

Example 2:

Harvested material = 50 t/ hour

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

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

Several methods have been used for estimating the compacting. All these methods are based on the calculation 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 sticking a finger into the silage *(Picture 13)*.

Picture 13. *Testing the silage compacting with fingers*

8 – 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 those values may be used as reference 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/ m^3	> 225	
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	

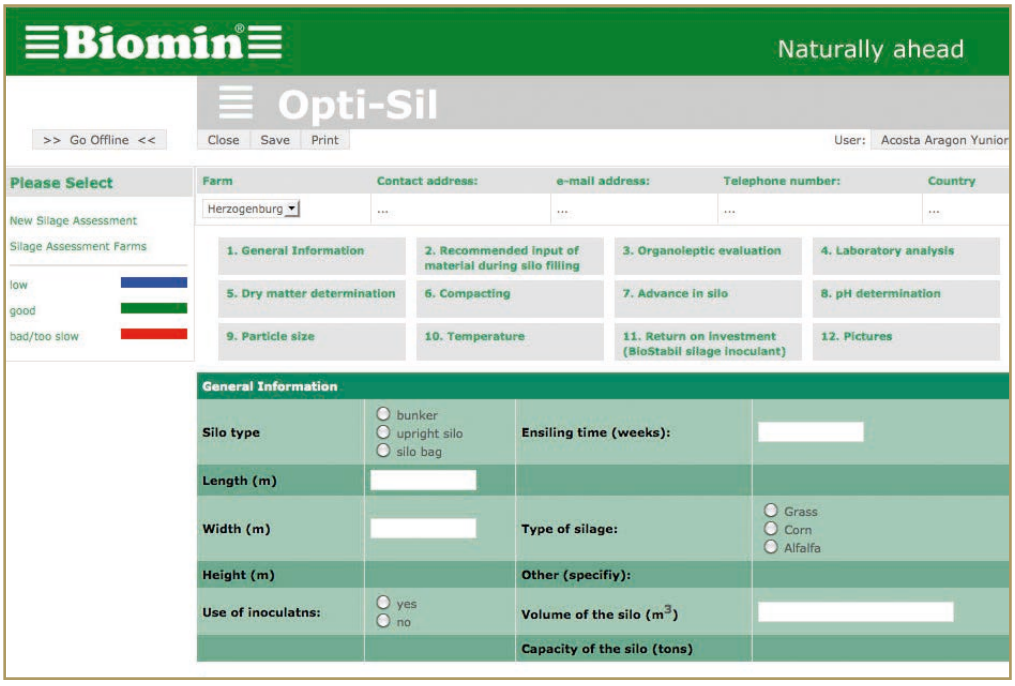
Table 9 *- Silage quality in fermentation*

Qualitative parameters	Unit	Reference value
pH (20 - 45 % DM)	-	3.5 – 5.0
Lactic acid	% in DM	1.5 – 4.0
Acetic acid (+ Propionic acid)	% in DM	2.0 – 3.0
Butyric acid	% in DM	max. 0.3
Ethanol	% in DM	< 1 (grass) < 2 (corn)
Ammoniac N from the total N	%	< 8

Table 10 *- Microbiological silage quality*

Microorganism	Value (cfu)	
	normal	increased
Yeast	< 1000 000	> 10 000 000
Moulds	< 5 000	> 50 000
Aerobic mesophile bacteria	< 1 000 000	< 10 000 000

The BIOMIN Silage Expert kit: contact your BIOMIN partner for more information



Opti-Sil, a unique software for higher silage quality.
More information at: **www.biomin.net**

9 – PROBLEMS IN THE SILAGES, CAUSES AND CORRECTIVE ACTIONS

To recognize the problems and to know possible causes are key factors for taking corrective actions at the harvest, or once the farmer opens the silo, as well as for a better understanding for the future. Also, the silage expert should know how to recognize the problems and look for solutions.

In the following *Tables (11 a, 11 b)* common problems in the silage quality are listed, as well as their possible causes and corrective actions.

Table 11 a) *- 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 till the crop reaches optimal dry matter values Wilting Use chemical products based on sodium nitrite and/ or formic acid Absorbents indicated (hay, straw, …)
High ash content (soil contamination)	Low dry matter content 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 blocs on the machine to increase the weight. An alternative can be to decrease the harvesting speed.

Table 11 b) *- Problems, possible causes and corrective actions for silages (continuation)*

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 the labors with an air tight silo sheet If the silo configuration makes it possible, divide the silo in two halves for doubling the speed in 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) The samples are not fresh During aerobic instability (lactic acid converted to ethanol)	Use an adequate homolactic silage inoculant for high protein silages Include extra energy sources or (molasses for instance, if feasible) treat the layer in contact with air with chemical products Include heterofermentative lactic acid bacteria in the future to prevent aerobic instabilities
Silage aerobic instability	Insufficient compacting Low feedout rate No silage heterolactic inoculant used Bad airtight sealing	Check compacting, as well as the particle length and the dry matter, and decision making for the next silage season Use heterolactic silage inoculants in the future Check the dimensions of the silo and the needs of the farm. If needed, divide the silo in 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) Speed the feedout rate up Treat the layer in contact with air with a chemical product, if needed re-ensiling in extreme cases (increases the cost) using a chemical product

10 – MOULDS AND MYCOTOXINS IN SILAGES:

The most common moulds in silages are listed in the *Table 12*, as well as the mycotoxins they produce.

The appearance of some moulds on silages are shown in the following *pictures (14 – 16)*.

Picture 14.
Penicillium roqueforti

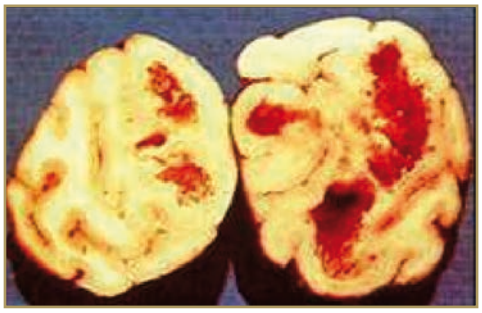
Picture 15.
Monascus ruber

Picture 16. *Aspergillus fumigatus*

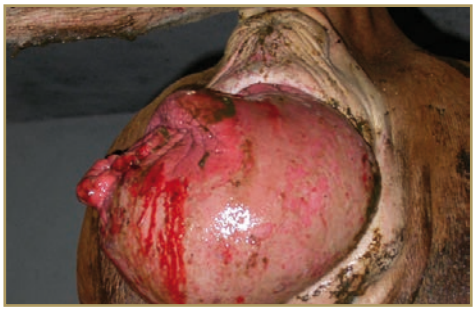
Table 12 *- Silage fungi and their mycotoxins*

Mycotoxin-producing fungi	Appearance	Mycotoxins
Aspergillus	Yellow – green Black *(Aspergillus niger)*	Aflatoxin (B_1, B_2, G_1, G_2), ochratoxin (A), patulin, cyclopiazonic acid (CPA)
Claviceps	Dark brown, black	Ergot alkaloids: Clavines (argroclavine), lysergic acids, lysergic acid amids (ergin), ergopeptines (ergotamine, ergovaline)
Fusarium	Yellow	Fumonisin (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
***Neotyphodium* (formerly *Acremonium*)**	Vary strongly	Tall fescue toxins: Ergot alkaloids (ergovaline), lolines, peramine, Lolitrems

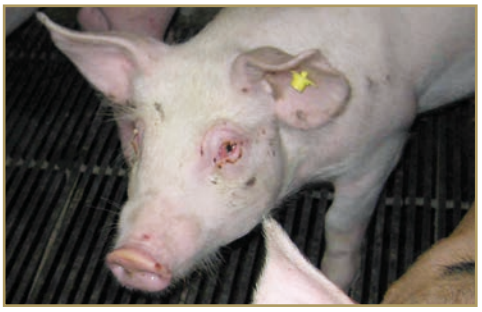
The following pictures show the main effects of mycotoxins on species which consume silages (cattle, horses, pigs).



Picture 18. *Negative effects of mycotoxins on horses (equine leucoencephalomalacia or "hole-in-the-head-disease" caused by fumonisins)*



Picture 17. *Negative effects of mycotoxins on cattle (from top to bottom: OTA: uterus prolapse; Trichotecenes (DON, T-2 toxin, ...); diarrhea))*



Picture 19. *Negative effects of mycotoxins on pigs (top: DON, T-2: Conjunctivitis; bottom: ZON, DON: splaylegs)*

THE BIOMIN SILAGE MANAGEMENT PROGRAM IN ACTION

The the BIOMIN Silage Assessment goes beyond its original purpose. It can also be used for practical determinations, for example, in exhibitions. The following examples show where the BIOMIN Silage program was showcased.

1 - EL SALVADOR AND CZECH REPUBLIC

After a visit to a Central American farm and to other Central European farms, an excellent practice was found: after covering the silo with adequate plastic sheets, the producers used bricks and cement blocks respectively to keep the silo airtight *(picture 32)*. In spite of the huge differences in production scale (silo capacity of approx. 200 and 5 000 tons for El Salvador and Czech Republic, respectively) and climate conditions, the idea and the aim is the same: minimize or even eliminate the possibility for air penetration into the silo.

Picture 32: *Silo covered with plastics sheets and a) bricks in El Salvador (top) and b) cement blocks in Czech Republic (bottom)*

2 - AUSTRALIA

Non-covered silages suffer from high dry matter, nutrient and energy losses. The Australian silage was not covered and furthermore had drainage problems *(picture 33)*.

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

Picture 33: *a) Silo uncovered and with drainage problems (top), b) the upper layer must be discarded (bottom)*

- 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 t
- **Economical losses: 6.5 t x 70 USD/ t = 455 USD**
- **Cost for covering 50 m^2: 75 USD**

Difference: 380 USD

Nevertheless, the calculation above is only referring to the fresh matter losses. To calculate the total losses in performance, due to non/ insufficient covering, the mycotoxin contaminations also have to be taken into account.

8 - AUSTRIA AND USA

A common problem for some silage producers is a wrong estimation of the storage capacity (underestimation of the needed capacity, lack of space for fulfilling the needs during the year). In such cases creativeness is required to overcome problems like those shown in the *picture (34)* below.

These silos are difficult to manage. Besides aerobic instability, enormous losses, etc. it is dangerous for humans in the case of collapse.

Picture 34: *a) Overloaded silo in an Austrian biogas plant (left), b) oversized silo in USA (right, courtesy of Mr. Telmo Rodrigues)*

9 - PORTUGAL

Povo de Varzim, Porto

Despite both of the *pictures 35 a and b* have being 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 pictures, the silages also differ very strongly in compacting.

Picture 35: *a) bad management of the silage layer in contact with the air (left), b) excellent management of the silage during the feed out phase (right)*

That is the reason why inoculation of the right silage was completely successful, while the left one was completely unsuccessful.

Alentejo

Picture 36: *Excellent covering of the silo with an internal thin plastic sheet, an external thick plastic sheet with ultraviolet light protection and silo bags*

10 - CHINA

The picture of a corn silage, in which the particle length *(picture 37)* is too long, shows that corn grains are not broken; this entails a bad digestibility as corn goes through the digestive tract without being used by the animal.

Picture 37: *Long particle length in corn silage under Chinese conditions*

4. BIOMIN SILAGE ASSESSMENT PROGRAM: AN EXAMPLE

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

An example of a final report is shown here:

BIOMIN Silage Assessment Program

Country: Uruguay
Farm: XY
Date: 17.08.2010
Farm technician: Ing. Jorge
BIOMIN´ and Norte Sur´s staff members:
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 other ethanol smell

II – Particle length:

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

For corn whole plant silage, the recommendation is to use a particle length of 4 to 7 mm.

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

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 degrade slower, decreasing the feed intake and therefore the animal productivity *(Picture I c)*.

Picture I. *a) long particle length (top left), b) big pieces of corncob (top right) and c) long pieces of stalks (bottom)*

III – Compacting:

Generally speaking good, however, in some places the material is not compacted enough *(Picture II a).* It leads to the formation of "air pockets" *(Picture II b and c)*. Their consequence will be discussed below.

Picture II. *a) testing compacting (top left), b) air pocket (top right) and c) mouldy area (bottom)*

IV – Time of silo filling:

The silo filling lasts more than 1 week. The optimal filling time is 1 day, maximally 3. It was recommended to increase the capacity of the harvesters, eventually looking for cooperations with contractors.

V – Covering:

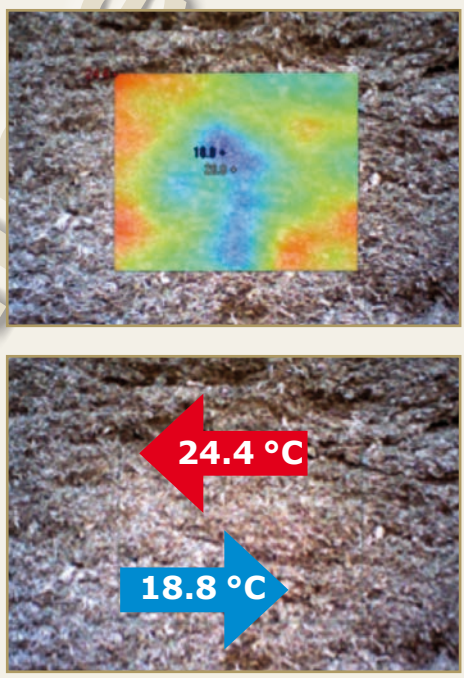
The upper silage layer was considerably spoiled (approx. 10 – 20 cm, *Picture III a*), especially on the borders near silo walls *(Picture III b)*. A simple calculation allows to estimate quantitative losses in approx. 270 tons in each silo [(150 x 28 x 0.10 m) x 0.65 tons/ m^3].

Picture III. *a) Deterioration of the upper layer (left), b) deterioration at the silo walls (right)*

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

VI – Aerobic stability:

Thermo pictures of the silage were taken *(Picture IV a)*. On *Picture IV b* marked temperature differences are shown (from 18.8 to 24.4 °C). It corroborates that the silage is spoiling or having aerobic stability problems.



Picture IV. *a) thermo picture of the silage (left) and*
b) differences in silage temperature

Those exothermic reactions are mainly the result of the yeast action. They:

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

Therefore, it is recommended to:

1- Emphazise the compacting
2- Increase the advance in the silo (see point VII), eventually dividing the silo in two halves
3- Utilize an inoculant which can prevent aerobic instability containing heterofermentative bacteria

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)**	tons/ day	29.4	14.7

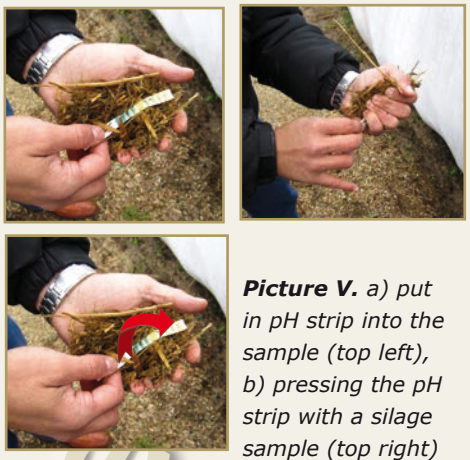
** Need of daily silage extraction = [recommended advance per season x width x height (m) x density (kg/m^3)]/ 1 000*

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:

By using a pH strip *(Picture V)*. The average pH values from 3 different places was 3.8. It means that the acidification was good. This is common for corn whole plant silage.



Picture V. *a) put in pH strip into the sample (top left), b) pressing the pH strip with a silage sample (top right) and c) reading the pH value on the pH strip (bottom)*

IX – Cut of the silage:

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

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

X – Contamination with moulds:

Several places were contaminated with fungi, not only in the upper layer *(Picture VII a)* but also inside the ensiled material *(Picture VII b)*. This leads again to the remaining air pockets in the silage.

Picture VII. *a) contaminated upper silage layer (left), b) formation of mould colonies (right)*

Samples of the silage were sent to an external laboratory (QUANTAS Analytics, Austria). The mould 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* (former *Absidia*) *ramosa*, respectively. These moulds have been associated with human mycosis, which can be lethal *(A. fumigatus)*, and abortions in cows *(L. ramosa)*.

A contamination of 4 000 cfu/g of silage is still considered as "normal". That silage showed a contamination 15 000 times higher.

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

See recommendations point V.

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.

5. CONCLUSIONS

The BIOMIN Silage Assessment is a tool for making decisions and evaluating the results of a very complex topic: the ensiling technique. Its use permits the evaluation of the silage quality and improves the silage making process.

An instructional video about BIOMIN‘s Silage Assessment Program is available at:

http://biostabil.biomin.net

An auxiliar program for evaluating the silage quality according to the BIOMIN silage assessment is available at:

http://optisil.biomin.net

Notes

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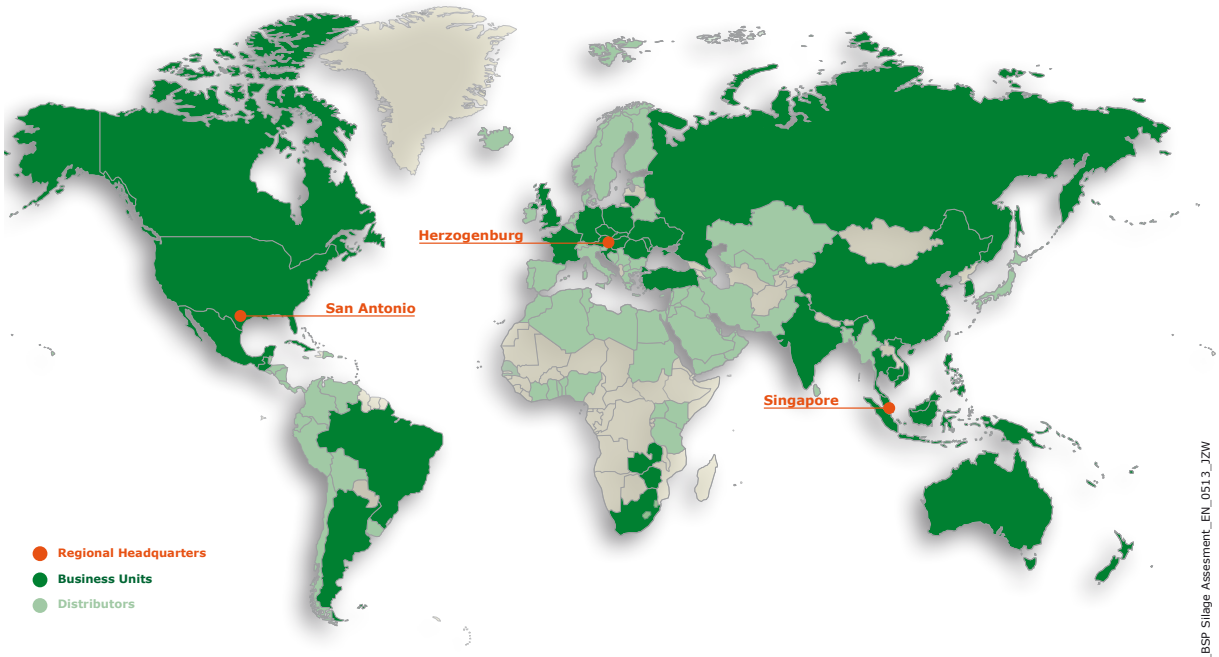

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