Film bound bales promote consistent crop preservation

Film bound bales, using 3D wrapping and Intelliwrap, are better preserved than bales bound with net and conventionally wrapped in multiple layers of film. This is the main finding of a study carried out in 2021 and 2022, conducted by Kuhn in cooperation with Eurofins Agro in Wageningen. Intensive sampling of both types of bales investigated the feed value and preservation quality.

After six weeks of storage (July 2021), no significant differences in the feed value and preservation quality were found between net bound and film bound bales. However, after eight months of storage (February 2022), the film bound bales had a significantly lower butyric acid concentration than the net bound bales. According to Bob Fabri, feed and preservation expert at Eurofins Agro, the beneficial bacteria in the film bound bales dominated, resulting in a clearly better preservation quality of the bales. This superior preservation was further demonstrated by the almost negligible presence of mould formation in the film bound bales, contrary to the net bound bales. The shape retaining stability of both bale types were similar.

Film binding in addition to net binding

In recent years, the techniques used to bale and wrap round bales have been increasingly refined and enhanced. Three key developments are the introduction of film binding in addition to net binding, and 3D wrapping and Intelliwrap technologies (see boxes). A practical trial performed in 2021 examined the benefits of these three developments.

Net binding versus film binding

The goal of the study was to compare bales bound with net and conventionally wrapped in several layers of film, with bales bound with film and wrapped in film, using 3D wrapping and Intelliwrap. The subject of the study was therefore two groups of bales that were compared according to the following parameters:

- Feed quality (determined by Eurofins Agro)
- Mould formation (visually assessed)
- Shape retaining stability of the bale (visually assessed)

The main question to be answered by the research was: what is the difference between a conventional net bound and wrapped bale (6 layers of film) compared with a film bound and 3D wrapped bale (5 layers of film)?

Kuhn's research shows that film bound bales (left) are better and cheaper than net bound bales.

INTELLIGENT WRAPPING

Intelliwrap is the system developed by Kuhn that, by varying the rotational speed of the round bale during wrapping, enables the number of layers of film used to wrap the bale to be precisely controlled. In other words, both even and odd numbers of layers can be applied. This process takes place fully automatically after the number of layers of film required is entered on the terminal. The rule of thumb is that the drier the crop is harvested and the longer the intended storage period, the more layers of film should be applied. The table shows the number of layers of film required for a bale based on both parameters.

INTELLIWRAP WRAPPING

Recommended number of layers				Storage time (months)					
				2	4	6	8	10	12
Dry matter content	Dry / Average / Humid	70%	Number of layers	7*	8	8	9*	10	10
		65%		6	7*	8	9*	9*	10
		60%		6	7*	8	8	9*	9*
		55%		6	6	7*	8	9*	9*
		50%		5*	6	7*	7*	8	8
		45%		5*	6	6	7*	7*	8
		40%		5*	5*	6	6	7*	7*
		35%		4	5*	6	6	6	7*
		30%		4	4	5*	6	6	6
		25%		4	4	5*	5*	6	6

** INTELLIWRAP for the perfect match* *Good setting for optimal quality*

Hard/prickly material may require more layers of film

Depending on the dry matter content and the storage period, Intelliwrap allows the precise number of film layers necessary for the bale to be set, i.e. both an odd and an even number of layers.

12 hectares cut and ensiled

In June, 2021 12 hectares of grassland (4-5 years, perennial ryegrass, sandy soil) were cut and ensiled at the farm owned by Jos Kuypers in Aarle-Rixtel (the Netherlands). All the bales were baled, bound and wrapped with the Kuhn FBP 3135 fixed chamber baler-wrapper combination. The film thickness was 25 mu, the film colour was Eco-Green.

Group 1: bales bound with 2.75 layers of net and conventionally wrapped with 6 layers of film
Group 2: bales bound with 3 layers of film and wrapped with 5 layers of film using 3D wrapping and Intelliwrap

Whilst baling, grass samples were taken by crop research organisation Eurofins Agro for the purpose of analysing the feed value. In addition, a composite sample was also created by combining samples taken from various swaths.
Forage quality samples were taken by Eurofins Agro after a period of 6 weeks. Two composite samples were taken per group of bales: one for feed value analysis and one for conservation analysis. Material was sampled/probed from 4 bales in each group.

After 8 months (February 2022), quality samples were taken again from each group of bales: one for feed content analysis and one for conservation analysis. The purpose of taking these samples was to determine how much feed value had been lost from the bales during the storage period. During the second round of sampling, probes were inserted into the same bales used during the first round of sampling, but the samples were taken from the opposite side of the bale.

When the bales were opened, a visual assessment was made of the amount of mould present and the location of any mould patches in the bales. An assessment form was completed for each bale, that used the following criteria to assess mould

formation: location per patch of mould, number of patches of mould and volume of mould per patch. The criteria were scored on a scale of 1 to 10, whereby 10 is the highest score (no mould anywhere in the bale).

Only film was applied to one type of bale, while net and film were applied to the other type of bales. During the study, therefore, the binding and wrapping costs of both bale types were compared separately.

Less butyric acid after 8 months of storage

The analysis results of the first composite sample taken during baling in June 2021 are shown below:

Composite sample June 2021

Dry matter content	**45,1%**
NEL	5,70 MJ/kg DM
Crude ash content	6,8%
VCOS	71,9% per kg OM
Crude proteïn	9,0%
Crude fiber	30,0%
Sugar content	14,8%
NDF[1]	59,4%

[1] *Neutral Detergent Fibre*

The results of feed content analysis and conservation analysis of the samples taken from both bale groups after 6 weeks (July 2021) are shown below:

Feed content analysis July 2021 (6 weeks storage)

Feed content	Net binding 2,8 layers, film wrapping 6 layers	Film binding 3 layers, film 3D wrapping 5 layers
Dry matter content	42,3%	45,1%
NEL	5,64 MJ/kg DM	5,73 MJ/kg DM
Crude ash content	9,0%	8,7%
VCOS	72% per kg OM	72,2% per kg OM
Crude proteïn	9,1%	9,2%
Crude proteïn total	10,5%	10,3%
Crude fiber	31,5%	31,9%
Sugar content	11,1%	9,8%
NDF[1]	57,5%	58,5%

[1] *Neutral Detergent Fibre*

Conservation analysis July 2021 (6 weeks storage)

Conservation	Net binding 2,8 layers, film wrapping 6 layers	Film binding 3 layers, film 3D wrapping 5 layers
pH	6,0	5,7
Butyric acid	1,5 g/kg DM	1,5 g/kg DM
Acetic acid	5 g/kg DM	5 g/kg DM
Lactic acid	5 g/kg DM	4 g/kg DM
NH3 fraction	13% per CP total	11% per CP total

3D WRAPPING

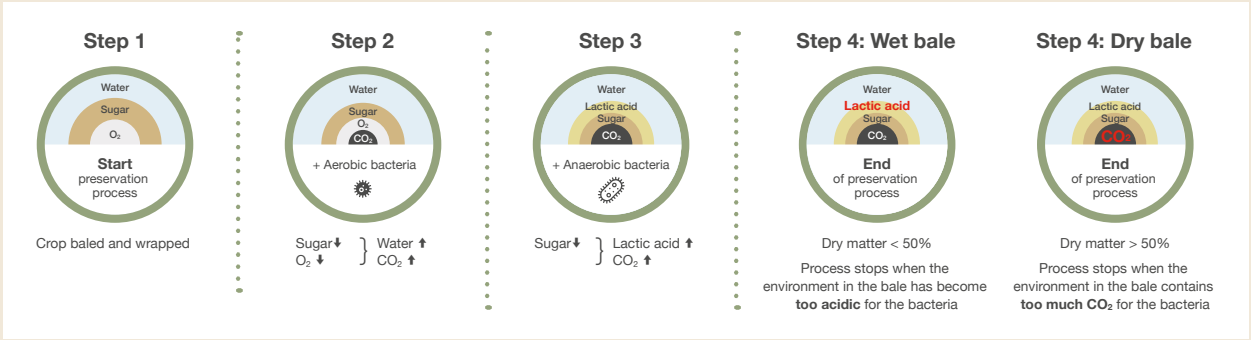
3D wrapping is a system developed by Kuhn which applies proportionally more layers of film to the rounded side and the corners of the bale than to the ends of the bale.

This is done by turning the film roll a quarter of a turn while the bale is being wrapped. This gives added protection to the places where the bale needs it most. During wrapping, the film is stretched to 70%, which pulls the film around the outside of the bale like a rubber band. This ensures that as much air as possible is forced out of the bale, which contributes to better preservation.

By turning the film roll a quarter of a turn at the start of wrapping, the rounded side and the corners of the bale are wrapped first. This 3D wrapping technique offers added protection to these vulnerable parts of the bale.

PRESERVATION PROCESS

The preservation process is performed by bacteria that occur naturally. A bale contains substances such as sugars, proteins and water. And to start with, oxygen in the form of air is also present in the bale. After ensiling, aerobic bacteria starts the preservation process. These bacteria converts the sugars with the oxygen into CO_2 and water. This causes a loss of energy (i.e: sugars) and dry matter. This process continues until the oxygen is consumed. The anaerobic bacteria then take over the process. They also consume sugars, but convert them into lactic acid and CO_2. This process reduces the acidity (pH) and increases the CO_2 concentration. Eventually the process stops, depending on the dry matter content, or based on the pH (at less than 50% dry matter, i.e. relatively wet silage), or based on the CO_2 concentration (at more than 50% dry matter, i.e. relatively dry silage). After this, the bale is stable and can be stored for a longer period.



There were no significant differences found between the two bale types after 6 weeks of storage. At 11%, the ammonia fraction of the bales with film binding was slightly lower than the bales with net binding (13%).

The results of feed content analysis and conservation analysis of the samples taken from both bale groups after 8 months (February 2022) are shown below:

Feed content analysis February 2022 (8 months storage)

Feed content	Net binding 2,8 layers, film wrapping 6 layers	Film binding 3 layers, film 3D wrapping 5 layers
Dry matter content	42,2%	44,9%
NEL	5,66 MJ/kg DM	5,73 MJ/kg DM
Crude ash content	8,3%	8,2%
VCOS	71,8% per kg OM	72,0% per kg OM
Crude proteïn	10,0%	10,2%
Crude proteïn total	11,4%	11,4%
Crude fiber	33,4%	34,2%
Sugar content	9,7%	8,7%
NDF[1]	60,3%	60,5%

[1] *Neutral Detergent Fibre*

There were no significant differences in feed content found between the two bale types after 8 months of storage.

Conservation analysis February 2022 (8 months storage)

Conservation	Net binding 2,8 layers, film wrapping 6 layers	Film binding 3 layers, film 3D wrapping 5 layers
pH	5,6	5,5
Butyric acid	9,2 g/kg DM	4,9 g/kg DM
Acetic acid	5 g/kg DM	10 g/kg DM
Lactic acid	9 g/kg DM	4 g/kg DM
NH3 fraction	13% per CP total	11% per CP total

The conservation analysis, however, did reveal a difference, which mainly related to the concentration of butyric acid. After 6 weeks of preservation, the concentration was identical for both bale groups: 1.5 grams per kilogram of dry matter. There was a clear difference after 8 months of storage. In net bound bales, the butyric acid concentration had increased to 9.2 grams per kilogram of dry matter, while with the film bound bales the figure was only up to 4.9 grams per kilogram of dry matter. The difference in ammonia fraction between the two bale types remained unchanged: 13% with net bound bales and 11% with film bound bales.

Group	Binding	Wrapping	Rating (1-10)
1	2,8 layers of net	6 layers 2D	6,95
2	3 layers of film	5 layers 3D	9,67

The visual assessment of patches of mould in the 2 groups of bales revealed a score of 6.95 (out of 10) for the group of bales with net binding and 9.67 (out of 10) for the bales with film binding. This is a clear difference, whereby the bales with film binding were practically free of patches of mould.

Best conservation with film bound bales

The biggest difference found, is the significant change in the concentration of butyric acid between the two bale types after 8 months of storage. Based on this data, Bob Fabri of Eurofins Agro states that the preservation status of the film bound bales with 5 layers of film (with 3D wrapping) was better than the net bound bales with 6 layers of film. He refers to the delicate process of preservation, during which aerobic bacteria become active first, followed by anaerobic bacteria (see box). There are beneficial anaerobic bacteria such as lactic acid bacteria and less beneficial strains such as butyric acid bacteria. Fabri: 'To put it simply, butyric acid bacteria will dominate if the conditions are not favourable for beneficial bacteria such as lactic acid bacteria. The higher the butyric acid concentration, the poorer the process of preservation. This manifests more clearly as the storage period becomes longer.' In this context, Fabri emphasises the importance of ensuring there is as little air in the bale as possible when ensiling. 'The faster the oxygen is consumed by the aerobic bacteria, the sooner the anaerobic bacteria can start their work and the less energy and dry matter it costs. This result shows that this effect was superior in bales bound in film compared with net bound bales.'

The slightly lower ammonia fraction is another indicator of a slightly better preservation process in the film bound bales. The ammonia fraction indicates how protein has been broken down by the bacteriocins, which use sugar first for their preservative effect before switching to protein. The faster the preservation process takes place, the less protein is consumed. Fabri: 'The lower the ammonia fraction, the better the preservation, as less protein has been lost.'

Other conclusions are:

- The film bound bales showed clearly fewer patches of mould than the bales bound with net. This is a clear sign of a better preservation process in bales bound in film compared with net bound bales.
- Binding bales with film is more expensive than binding bales with net. However, because the TWIN-reel binding system on the baler-wrapper uses standard rolls of stretch film instead of the more expensive mantle film, the additional costs are low. As a layer less of film is used in the wrapping process, the total savings on the wrapping costs are higher than the extra costs of film binding.
- The shape retaining stability of both bale types was similar.

In answer to the sub questions addressed by the study, the final conclusion is that the film bound bales, with 5 layers using the 3D wrapping technique, are better preserved than the net bound bales, conventionally wrapped with 6 layers, because there is less oxygen ingress in the bales bound with film. As a result, there is a lower butyric acid concentration, a slightly lower ammonia fraction and practically no patches of mould. The bale quality has therefore been improved, with lower total costs for binding and wrapping.

Kuhn Baling Test

Watch the video recording of this study.
Scan the qr-code or click **here**.