Department of Economic Development, Jobs, Transport & Resources

Stretch Wrap Films ain't Stretch Wrap Films

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Forage wrapped in stretch wrap film as baled silage is expensive forage but good and economical forage if cut early in the season, wilted to the correct dry matter (DM) content and sealed with the latest plastic technology. With the expense of growing, harvesting and feeding out bales, DM and quality losses need to be reduced at all stages from standing grass to harvesting to storage to feeding out.

The aim for baled silage stretchwrap film is to have excellent puncture resistance, ultra-violet (UV) light inhibitor, constant and even stretch on application and prevent oxygen from entering the bale. Whether 3 or 5 layers it must also incorporate sufficient tack levels in the layers to deliver a tough, high-performance bale wrap that operates well for both day and night in all climates.

In the latter years stretchwrap film has been made from coextruded, linear low-density polyethylene (PE) films in 3 and 5 layered forms. Of course each company argues that their film offers the most benefits and least drawbacks and there are always the ethical manufacturers who produce high quality films and others not so ethical. However, there is still occasionally the odd film coming to Australia from some companies in the Northern hemisphere and Asia-Pacific to get rid of their excess film at the end of their season and the start of Australia and NZ's, usually at a discounted price. Often these films do not contain enough concentration of UV light inhibitor for our higher solar radiation and the film breaks down way too quickly (within months) after application.

The technology of stretchwrap plastic for the sealing of baled silage continues to improve each year and this year sees another player in the paddock.

As with other stretchwrap films, this latest stretchwrap technology has also been developed and tested in Australia and New Zealand over the last couple of years to ensure the product is suitable to our harsh conditions and that the film does the job very well. This new film has the Oxygen Barrier (OB) technology that is similar to the Oxygen Barrier film successfully developed for silage pits, stacks and bunkers. The OB layer is made from food grade plastics, it's a patented film with a layer of very impermiable plastic (ethyl vinyl alcohol, EVOH) sandwiched between layers of polyethylene.

This new OB film is nearly a 100 times more effective as a barrier to oxygen permeability than PE films. It is 25 micron thick. Table 1 shows the oxygen transfer rate through three stretchwrap films on the market as independently tested recently in Europe.

Table 1. Oxygen transfer rate through a range of high quality bale wrap films

Film Type	Thickness (micron)	Thickness at 70% stretch (micron)	Oxygen Transfer Rate @ O% stretch ($cm^3/m^2/24$ hrs)	Oxygen Transfer Rate @ 70% stretch ($cm^3/m^2/24$ hrs)
SILOSTOP Bale Wrap film	25	23	20	286
Regular bale wrap-Brand 1	25	18	1,978	11,650
Regular bale wrap-Brand 2	25	20	1, 871	9,240

Source: Innoform, Germany, 2015

The OB film is clearly less permeable to oxygen passing through the film compared to the other films, tested using single layers (Table 1). However early days as yet and the OB film due to its more expensive manufacturing cost will be dearer in the field and will need to show enhanced benefits. Already there are other manufacturers starting to market similar types of films in Europe and Australia.

The technology to implement this OB film into stretchwrap film has taken some time to be developed and no doubt will continue as with all stretchwrap films from other manufacturers. How good is it? How good is the UV inhibitor for Aussie and NZ conditions? How long before it breaks down in sunlight? How many layers are needed? What stretch is recommended? How long will it last? Can it be recycled? What is its cost? Would 6 layers of another high quality 3 or 5 layered film compare favourably with the OB film at 4 layers? These are just some of the questions which will arise this year.

To answer some of the above questions three research studies have been conducted with baled Lucerne silage in Italy, the country of manufacture of the OB film for silage stacks and now OB bale wrap film.

Three experiments examined the effectiveness of the type of stretchwrap on fermentation quality, mould growth on the bale surfaces and DM losses and in terms of spoilage and mould growth over an extended period (420 days). The films used were conventional polyethylene (PE) vs two new coextruded films with enhanced OB technology, polyamide (PA) and ethyl vinyl alcohol (EVOH).

Before use the three films were tested to specific and recognised standards for oxygen permeability at 23° C and 50° C (Table 2.). The two OB films, Medium OB (PA) and High OB films (EVOH) reduced oxygen permeability significantly more so than the conventional PE film. The two OB films (Medium and High OB films) reduced oxygen permeability significantly more so than the conventional PE film. Note the increased permeability at the higher temperature, a common situation in many Australian locations.

Table 2. Oxygen permeability of PE and OB films before stretching at 23° C and 50° C.

Film Type	Thickness (micron)	Oxygen Transfer Rate @ 23°C ($cm^3/m^2/24$ hrs)[1]	Oxygen Transfer Rate @ 50°C ($cm^3/m^2/24$ hrs)[1]
Conventional PE	25	7,120	21,360
Medium OB	25	408	2062
High OB	25	19	45

Source: Adapted from Borreani and Tabacco, 2010. University of Turin, Northern Italy
[1]Cubic centimetre per square metre per 24 hours at 1 bar pressure and 65% Relative Humidity (Test Standards)

After a storage period of 420 days, the plastic stretchwrap was removed and visible moulds on the sides and ends of the bales were located and measured. For the microbiological measurements of the yeasts and moulds, four cores were taken from the side of the bale from the surface to 120 mm depth. To measure the extent of mould over time further coring occurred in the same holes from 121 mm depth to 480 mm depth. Table 3 shows these results.

Table 3. Effect of three film types on mould (%), pH and yeast and mould counts on bale surface and core after 420 days storage

Trial No. (% DM)	Stretch Film Type	Total surface area covered by Mould (%)	pH	Bale Surface (0 - 120 mm)		Bale Core (121 - 480 mm)	
				Yeast $\log_{10}$(cfu/g)*	Mould $\log_{10}$(cfu/g)	Yeast $\log_{10}$(cfu/g)	Mould $\log_{10}$(cfu/g)
Trial 1 **(64 DM)**	H OB	7.1^b	5.4^b	1.68^b	0.98^b	1.04^b	1.23^b
	M OB	9.4^b	5.30^b	2.08^b	1.10^b	1.14^b	0.92^b
	PE	23.0^a	5.54^a	3.41^a	2.87^a	2.39^a	2.02^a
Trial 2 **(61.3% DM)**	H OB	4.0^b	5.33^b	2.54^b	1.99^b	1.94^b	1.90^b
	M OB	6.3^b	5.26^b	1.82^b	2.01^b	1.24	2.13^b
	PE	20.6^a	5.53^a	3.12^a	3.12^a	1.26	4.01^a
Trial 3 **(58.7% DM)**	H OB	3.1^c	5.19^b	1.07^b	1.43^b	0.90^b	1.60^b
	M OB	10.8^b	5.47^b	1.14^b	2.01^b	1.23^b	1.27^b
	PE	52.9^a	6.83^a	3.07^a	3.24^a	3.66^a	3.46^a

Source: Adapted from: Borreani and Tabacco, 2010. University of Turin, Northern Italy

* $\log_{10}$: A form of measurement to count extremely large number of micro-organisms. (cfu/g) is the unit used to estimate number of viable bacteria per gram of material

$^{a\ b}$ and : Averages in the same column and within trials followed by different letters are statistically different

Table 3 shows the results of Trials 1, 2 and 3. Both OB films reduced the amount of mould on the bale surface (sides and ends) by about 10 percent compared to PE films of about 20 percent in Trials 2 and 53 percent in Trial 3. The OB films also significantly reduced the yeast and mould counts in the outer 120 mm of the bale compared to the PE film. In most cases (not Trial 2 for the yeast count only) the yeast and mould counts in the OB films were also significantly lower than the PE films. The acidity of silage (pH) is an indicator of fermentation quality, the lower the pH, the better. Although low in numerical value, the OB films had significantly lower pH values than the PE films.

Ammonia nitrogen (NH_3-N) was determined and is a measure of the breakdown of crude protein (CP) during fermentation and is affected by DM content and oxygen trapped in the bale at baling or oxygen ingress through the film over time (and from holes in the film. The results are not shown as there were no difference between films at the surface or in the core apart from the core in Trial 3 where the OB films recorded lower NH_3-N (51.5 g NH_3-N/kg DM) compared to the PE film (96.0 g NH_3-N/kg DM). That is there was nearly twice as much crude protein breakdown in the core)

The DM losses have been reported in graph form and difficult to provide the actual numbers. However, the DM losses in Trial 1 were about 8.5 % DM for the PE film and the M OB and H OB films about 2 to 3 % DM. In Trial 2 the DM losses of the PE and M OB films and were between about 4.3 – 6.3 % DM respectively compared to the H OB film (about 1 % DM). In Trial 3 DM losses of PE and M OB films were between about 11.3% and 10.8 % DM respectively compared to the H OB film (6.8 % DM).

Another trial by Borreani and his team compared Italian ryegrass wrapped with four layers of PE or M OB film and stored for 140 days. Yeast counts were significantly higher for the PE film (3.49 $\log_{10}$ cfu/g) than for the M OB (2.59 $\log_{10}$ cfu/g). The loss of DM for the PE and M OB wrapped bales was 8.0% and 5.5 % DM respectively.

These results clearly show that four layers of the M OB and H OB films were equal to (and may be better in some aspects) than six layers of PE film.

One Australian trial with perennial ryegrass examined wrapped bales with four layers of PE and high OB films at 55% stretch. Surface (0 – 200 mm) and centre (600 mm) core samples were taken after 227 days and measured for Dry Matter (DM) content, acidity (pH), crude protein (% CP), water soluble carbohydrates and a few other quality measurements and the important yeasts and moulds.

Given this trial is about to be reported at future conferences in the very near future by those involved, I do not wish to say anything more than that the H OB film performed better than the PE film and similarly to the research by Borreani reported above.

Similar to most other PE films, the plastic is guaranteed for one year, 25 micron thick, similar tackiness, stretch and other characteristics. The film has no specific requirements for application. Four layers are satisfactory on round bales but should be six for square bales, tubelines and stemmy crops and if bales are to be transported. Stretch on round bales is 70% but should be about 55% on large square bales. Contrary to popular belief in some quarter, OB film is totally recycleable.

Cost will be higher and may be six layers of a high quality PE film will be equally or more economical notwithstanding the research by Borreani showing better bale hygiene. The proof is always in the eating of the pudding, i.e. animal production and animal health. As I have said in the past, watch this space for further developments from manufacturers in all stretchwrap films.