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The forages are chopped and put in a silo under anaerobic conditions where microscopic organisms (lactic acid bacteria) living on the grass in the field carry out the fermentation. Once complete, this “pickled grass” must be kept safe with a protective cover for use at a later date.

Traditionally, silage covers have been made of polyethylene. Polyethylene films are inexpensive and help keep water out of the silo but lack gas barrier. Inadequate protection against oxygen can negatively influence the quality of the silage. Furthermore, carbon dioxide, volatile fatty acids, ethanol and other odiferous gases can penetrate through traditional liners cause undesirable gas emissions in the air.

Ideally, carbon dioxide should be kept in and oxygen out to best preserve the nutritional value of the product, thus keeping farm animals healthier.

How do you accomplish this? Through high-barrier films made with EVAL™. For the past few years, silage covers made with EVAL™ have become a game-changer for farmers.

## A Powerful Protector

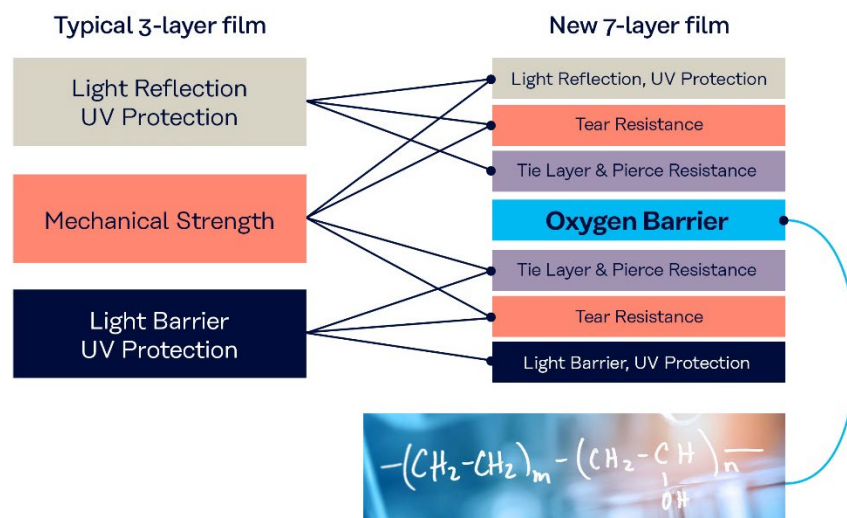
EVAL™ offers numerous characteristics that make it a powerful choice for incorporation into silage covers:

- **Oxygen and Gas Barrier**
  - Creates an anaerobic condition in the silage pile, which improves the natural fermentation of plant carbohydrates into lactic acid.
  - Preserves dry matter, sealing in fiber and other nutritional benefits.
  - Helps to stop the growth of surface yeasts and toxigenic fungus. This protects animals from getting sick, especially horses and sheep who have sensitive digestive systems.
- **Odor Barrier**
  - Lack of fumes and odors keep pests like rodents and deer away.
- **Nutritional Value Protection**
  - Better preserves dry matter, proteins, and silage quality.

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Multilayer coextruded films combine the toughness and water vapor barrier of polyethylene with the oxygen barrier and odor barrier of EVAL™. The Polyethylene layers can be pigmented white to reflect light on the outside of the pile. The Polyethylene layer can also be pigmented black to offer both visible light barrier and to protect the film against the effects of ultraviolet light.

## Benefit of 7 Layer Technology



## Grades Used in Silage Cover Films

Kuraray's unique proprietary manufacturing process has produced the world's widest available range of EVOH grades. It is a copolymer of ethylene and vinyl alcohol. The ethylene portion imparts the ability for it to be melt-processed in complex coextrusion systems. The vinyl alcohol portion provides the gas barrier.

As copolymer with high crystallinity and its unique chemical structure the gas barrier in the crystalline phase is essentially impervious to the diffusion of gases and the presence of the -OH (hydroxyl) group in the backbone of the polymer contributes hydrogen bonding, dipole-dipole interactions, and van der Waals forces all of which contribute to limiting the diffusion of gas and volatile organic compounds through the amorphous phase of the EVOH.

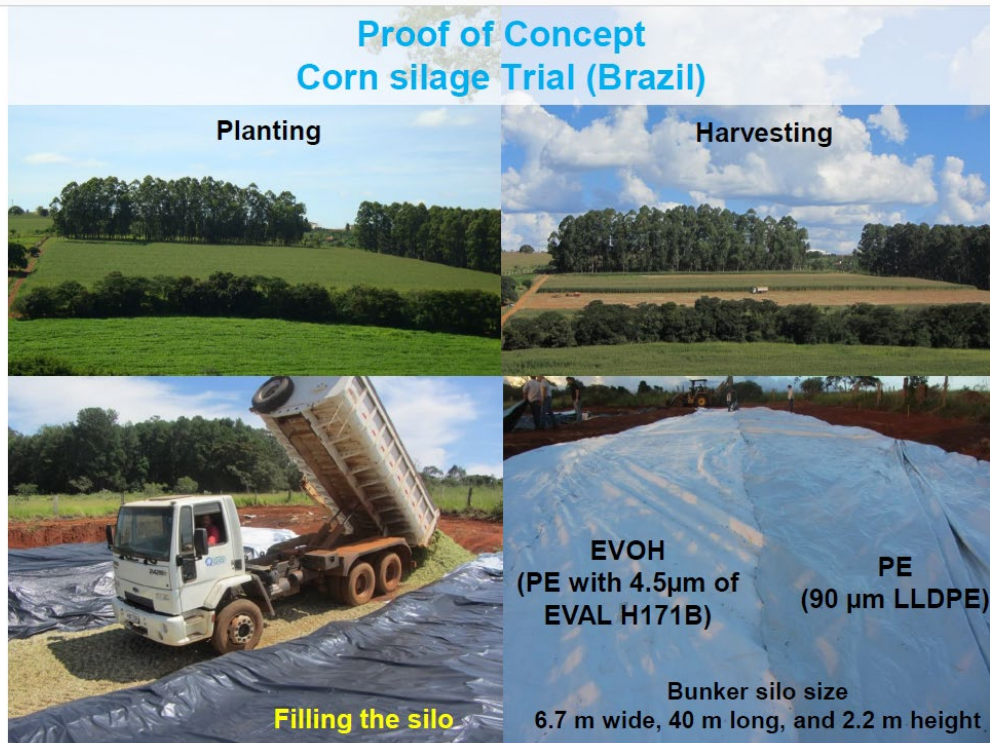
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Within silage covers, the most used grades are EVAL™ types F171B, H171B and E171B:

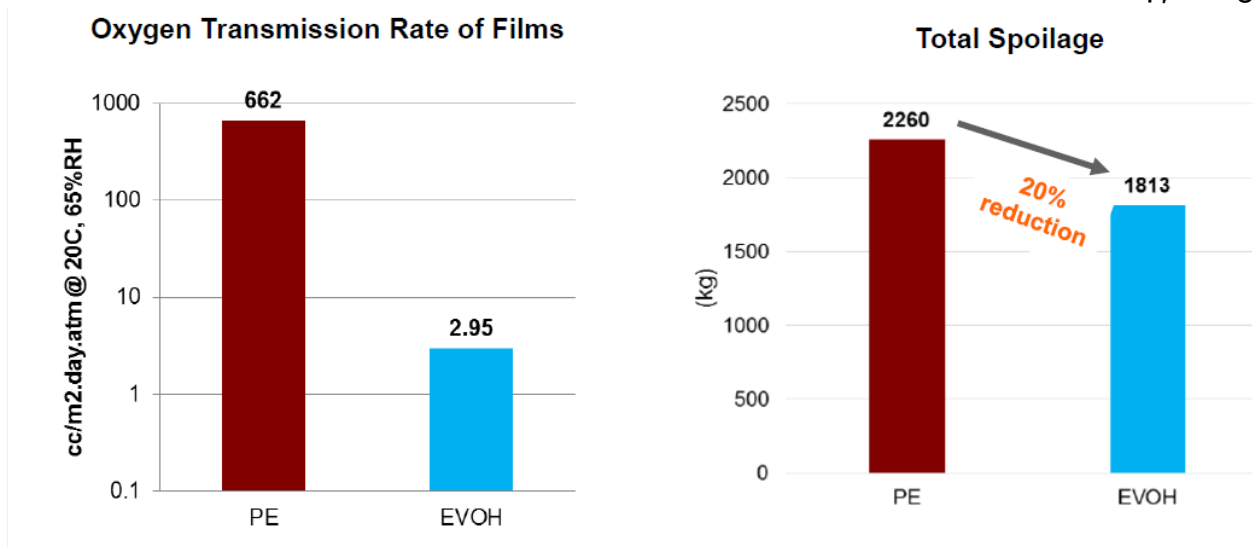
Grade	Ethylene (mol%)	Density (g/cm <sup>3</sup> )	Melt Temperature (°C)	Oxygen Permeability cc.20µm/day.atm (20°C, 65%RH)
L171B	27	1.21	190	0.1
F171B	32	1.19	183	0.3
H171B	38	1.17	172	0.7
E171B	44	1.14	165	1.9
G176B	48	1.12	157	3.7

**Case Study 1**

From 2012-2013, Kuraray worked with the Universidade Federal de Lavras (UFLA) to conduct a nine-month trial on whole crop corn silage conserved in an earthen ditch. The trial revealed a 20% reduction in spoilage loss.



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**Case Study 2**

In 2019-2020, Kuraray partnered with the University of Turin on a corn silage trial that studied multiple factors, including spoilage reduction, acidity, dry matter content, protein levels, volatile fatty acids and more.



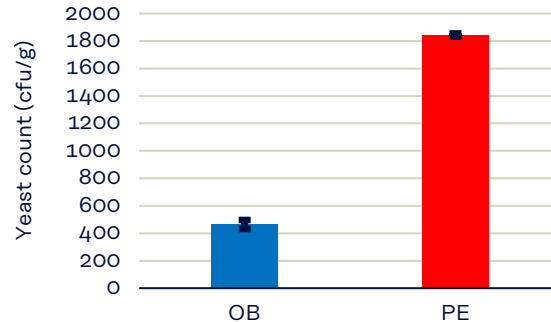
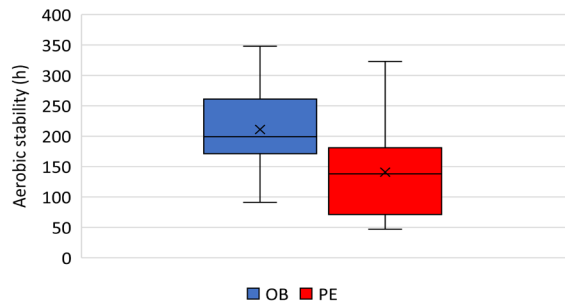
This time, the test was conducted in a concrete silo that was half covered in an EVAL™-based film (the other half in traditional Polyethylene).

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The study demonstrated that bunkers covered with plastic film are an effective way to manage fermentative and microbial parameters of the silage. OB films with EVAL™ demonstrated better ability to provide better aerobic stability by reducing yeast count in the silage and total spoilage versus PE film.

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### Making A Difference

Kuraray first presented EVAL™ to silage cover producers in 2010. Over the last decade, use of the product has been incorporated into numerous commercial applications in the U.S. and Europe. Trials run in different parts of the world clearly prove that silage covers made with EVAL™ are preserving the dry matter of the silage, as well as controlling fungi growth and pathogens.

### Acknowledgments:

Besides the two research institutions that conducted the studies, Kuraray would like to thank ...

- *Viaflex* (formerly Raven Engineered Films) in the USA for providing the barrier film for the study in Brazil
- *Barbier Plastics Solutions* in France for providing the barrier film for the study in Italy

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