Industrial experience regarding natural and low emission adhesives.

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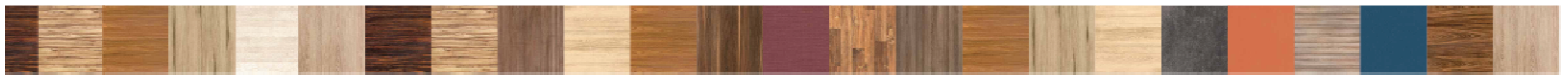
MASISA

Your world, your style

Index

- MASISA OVERVIEW
- LOW EMISSION PRODUCTION
- NATURAL ADHESIVE PRODUCTION & NAF
- CONCLUSIONS & NEXT STEP



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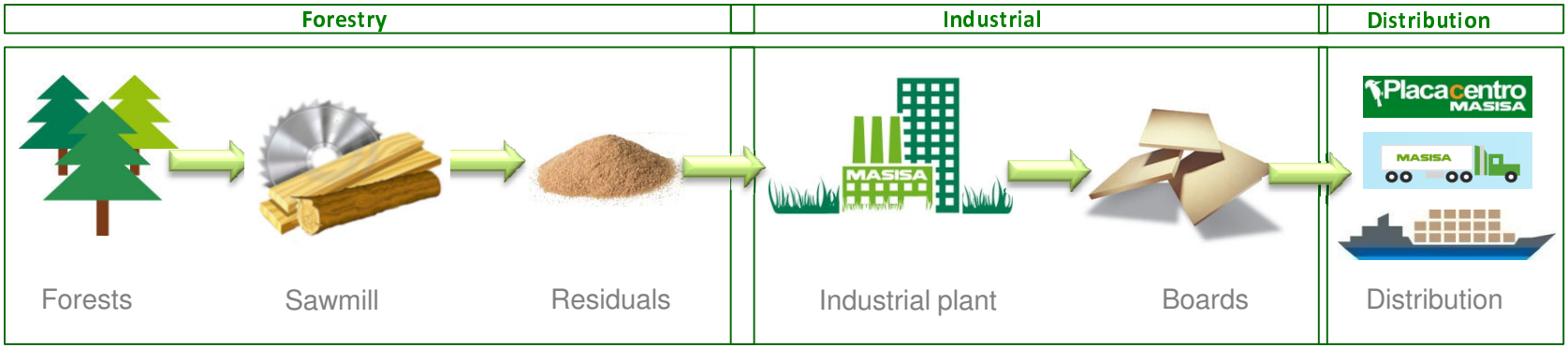
MASISA OVERVIEW

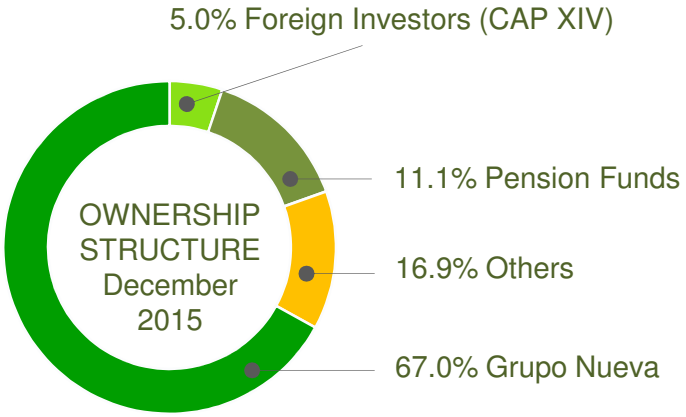
Masisa is a leader integrated company focused on **fiberboard** and **particleboard** production, marketing for furniture and interior design in **Latin America**

- #1 In installed capacity in Latin America, Brazil not included
- #1 In sales to 4 Latin American countries
- #1 in retail network distribution, with 333 partner stores in Latin America (Placacentro)
- #1 Top of Mind brand in Latin America
- #1 in Corporate Governance, environmental and social standards in the region

Business model



OWNERSHIP STRUCTURE



Supported by a Recognized Controlling Group

VIVA TRUST

- Founded in 2003
- Supports Grupo Nueva'S business, providing guidance and control.
- Finances AVINA foundation activities and other philanthropic initiatives

AVINA

- Latin American non-governmental organization that contributes to sustainable development by supporting social and environmental focused entrepreneurs

GRUPO NUEVA

- Investment company, focused on forestry and wood products business
- Controlling MASISA shareholders with 67% equity participation
- Grupo Nueva has supported Masisa by subscribing the two last capital increases of company in 2009 and 2013, to strengthen financial profile and support growth opportunities.
- Grupo Nueva's main asset is MASISA stake equity.

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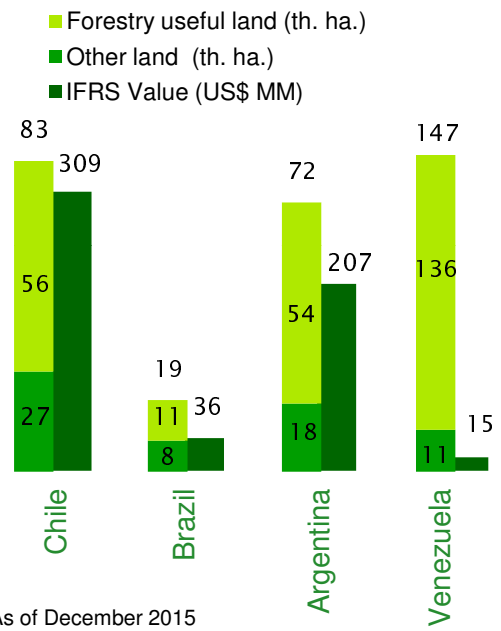
- MASISA's core is aimed to maximize value creation in LatAm wood board industry

INTEGRATED OPERATIONS FOCUSED ON MANUFACTURING AND MARKETING OF WOOD BOARDS

Forestry Assets → Industrial Assets → Distribution

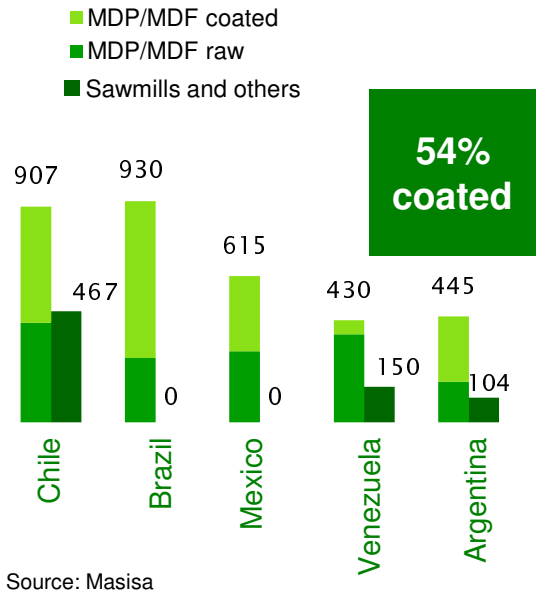
Forest assets by country



As of December 2015
Source: Masisa

- Stumpage: 198 Th. Ha. → US$ 316 MM
- Land: 322 Th. Ha. → US$ 251 MM
- Venezuela´s plantations mainly in leased lands

Installed production capacity by product and country (thousands of m³)



Source: Masisa

- 10 industrial complexes in 5 countries within the region.
- Excludes 220 th. m³ MDF plant under construction in Mexico at 2015

- Multichannel strategy
- 33% of sales through Placacentro retail network
- # 1 top of mind brand in Latin America

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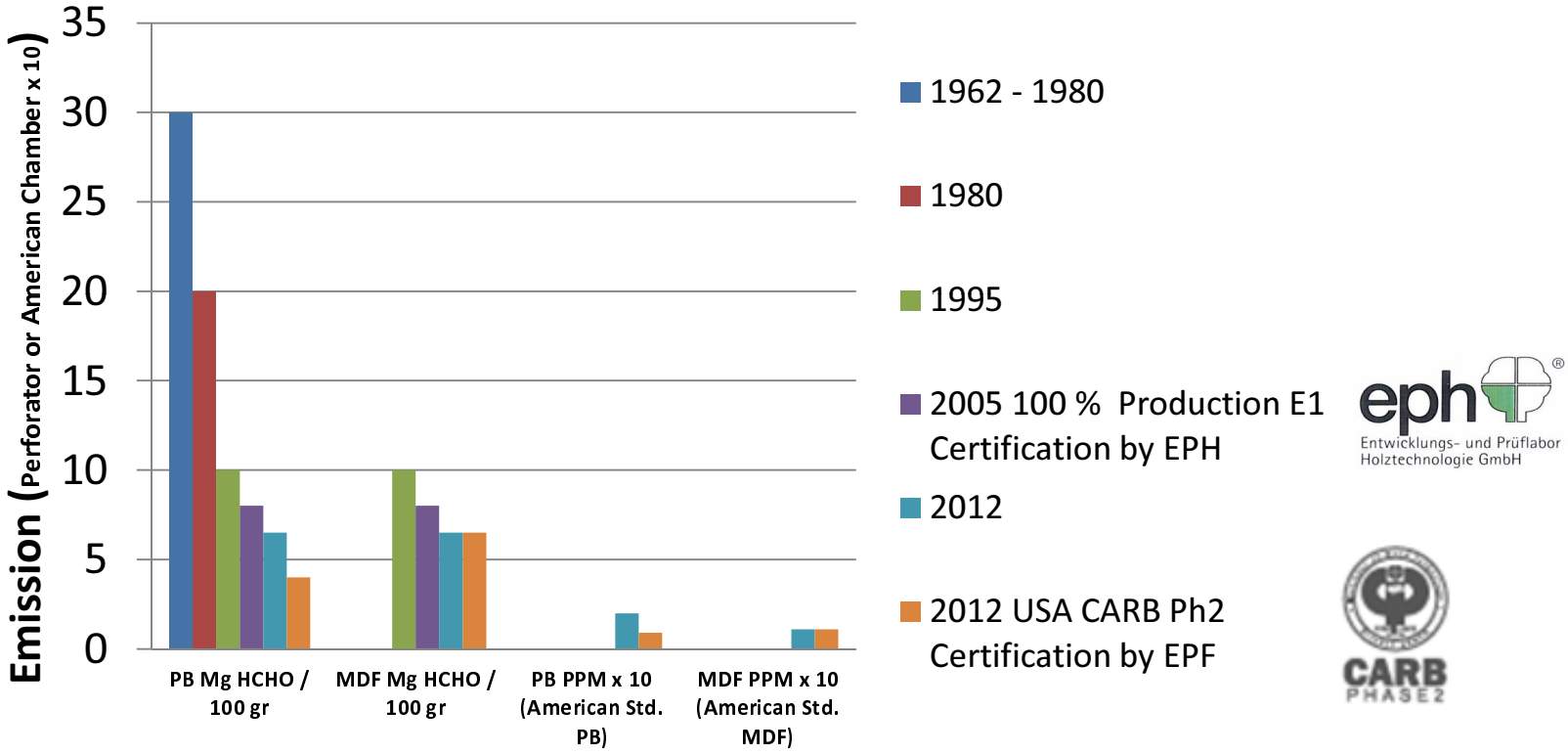
LOW EMISSION PRODUCTION

Formaldehyde Emission Evolution
Using UF or MUF adhesive



eph
Entwicklungs- und Prüflabor Holztechnologie GmbH

CARB PHASE2

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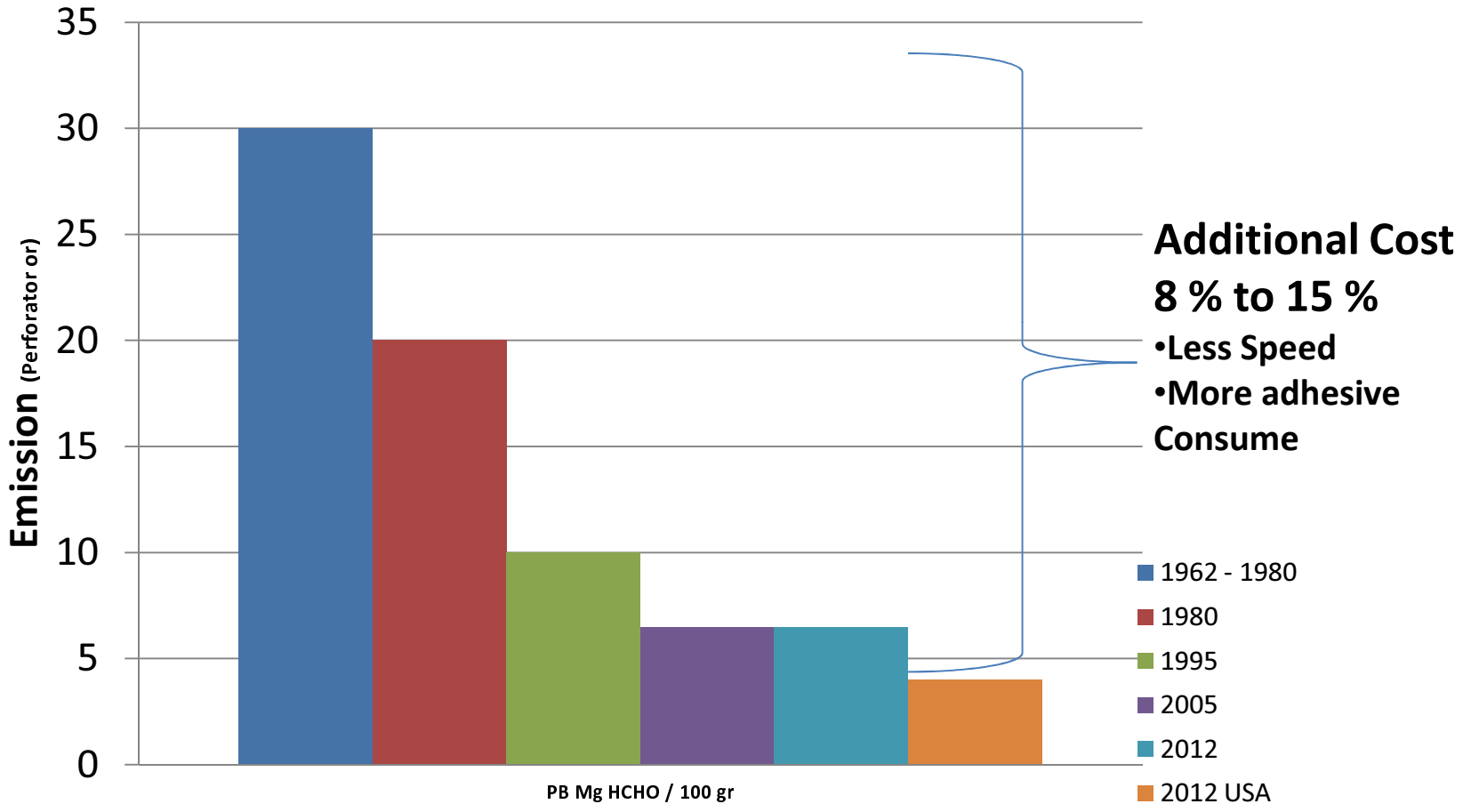
LOW EMISSION PRODUCTION

Formaldehyde Emission Evolution / Cost Impact
Using UF or MUF adhesive



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LOW EMISSION PRODUCTION

Termites.

Fungy.

But no only direct production impact

•E2 and higher have more resistance, better properties as a whole.

•Low emission needs higher attention, and new technologies.

Less Workability and Moisture Resistance

LOW EMISSION PRODUCTION

Market behavior.

•MASISA is a leader in sustainability in Latin America, therefore, a leader in Low Emission.

•Nevertheless, as Low Emission is not an issue in Latin America, MASISA should maintain a high effort and a strong R&D process to keep competitiveness in those "*problems*" that Low Emission may generate.

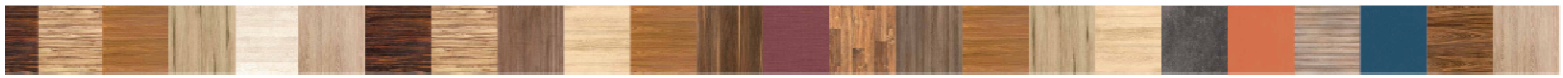
•MASISA works attempting to move different national standards towards a continuous reduction in formaldehyde contents and emissions.

We have some success :

- •New Standard in México similar to European E1.
- •New Standard in Chile by incorporating Emission's measurement. A system using Dynamic Micro Chamber.
- •We are promoting new Standard in Brazil.

•In our Latin American countries, safety , ecological and sustainable characteristics have values not over 10 % with respect to market price of panel boards.

•Today MASISA offer all Emission Levels : E1, Carb Ph2, F4 Stars, and NAF using MDI (MDF) or Natural Adhesive.



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LOW EMISSION PRODUCTION

Adhesive Technology.

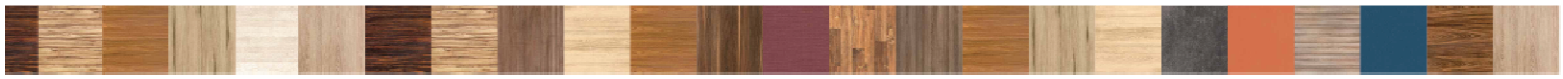
MASISA is using GP technology in Chile and Argentina.
Rexol , Momentive or Hexion in Brazil.
Own production Technologies are used in México and Venezuela.

We, basically use two adhesive mixture.

In PB for example : Adhesive 1 : Molar Ratio 1:1,1
Adhesive 2 : Molar Ratio 1: 0,6

For E1 production, mixture used is 80 % Adhesive 1 + 20 % Adhesive 2.

In some cases, we use urea solution and specific catchers, technologies are available, we only optimize cost.



NATURAL ADHESIVE PRODUCTION & NAF

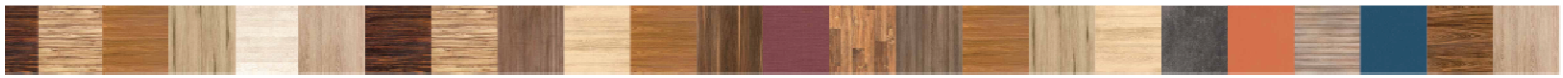
MASISA has a large history in natural adhesive an NAF natural adhesives

1993 : PB MR Production & Sale for nine years at Chiguayante Plant in Chile (decommissioned in 2012), using Natural Tannin from Bark Radiata Pine and tested in MDF (European Journal of Wood and Wood ISSN 0018-3768 Eur. J. Wood Prod. DOI 10.1007/s00107-012-0610-2 , J. Valenzuela · E. von Leyser · A. Pizzi · C. Westermeyer · B. Gorrini.).

Technology:

- Pine tannin was industrially extracted from Radiata Pine bark chips with hot water (with 2 % sodium bisulphite) (Sealy-Fisher and Pizzi 1992).

- Tannins Formaldehyde was Resin used for 9 years. Nevertheless, it was initially tested 30:70 PMDI – Tannins Formaldehyde and pine tannin adhesives, where hexamethylenetetramine (hexamine) was used rather than paraformaldehyde, the favorite hardener at that time, were also produced with excellent results.



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NATURAL ADHESIVE PRODUCTION & NAF

2008 : MASISA is part of Research Team on not adhesive production (NAF) , using Fenton Reaction, in Fiberboard.

(J. Chil. Chem. Soc., 53, Nº 3 (2008), FIBERBOARD MANUFACTURED WITHOUT RESIN USING THE FENTON REACTION, J.RIQUELME-VALDÉS, E.RAMÍREZ, D. CONTRERAS, J. FREER,J. RODRÍGUEZA).

Technology:

- Using Oxygen Peroxide H_20_2 (grade p.a.) and ferrous sulfate heptahydrate $FeSO_4x7H_2O$.

to obtain Rx. : $H_2O_2 + Fe(II) \rightarrow Fe(III) + \bullet OH$.

Those components “activate” some chemicals in Termomechanical pulps, and produce bounding, but process is not fully understood at the time when this alternative is assessed.

- Technology only worked in laboratory for thin MDF, but with low properties and at a really high cost. We did not make industrial trial; due to cost, the risk involved in using oxidant in our machinery and, because lab results were not as good as we expected.

NATURAL ADHESIVE PRODUCTION & NAF

2013 : Trials using NAF Soyad ™ (today Solenis company) adhesive based on soy protein in PB and MDF.

Technology:

- Soy flour with granulometry and purity under soyad industrial secret, but the adhesive is a mix :
Soy-poly-amidoamine - epichlorohydrin (Soy-PAE)
We use three products: Soy ad SD419, Soy ad DPA424, Soyad CL4180, and small MDI in addition.

•Adhesive worked really good in the industrial process, performance was perfect, similar to UF for E1 emission standard, and change between UF to Soya adhesive is undisturbed (Plug and Ply).

•Products we obtained were P2 European Standard and MDF class (Suitable for interior furniture) but thickness and swelling had lower limits.

Soy adhesive

First Industrial production in Mende Line

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NATURAL ADHESIVE PRODUCTION & NAF

2013 : Trials using Tannins NAF adhesive with new Georgia Pacific Technology in PB and MDF

Technology:

- Is a Secret GP Technology

Adhesive worked with some problems in the industrial process : we have to reduce speed and increase adhesive dosage or consumes.

Products we obtained were P2 European Standard and MDF Class (Suitable for interior furniture), but we expected thickness swelling to be near the MR panelboard (as our last experience).

First Industrial Tannins PB production

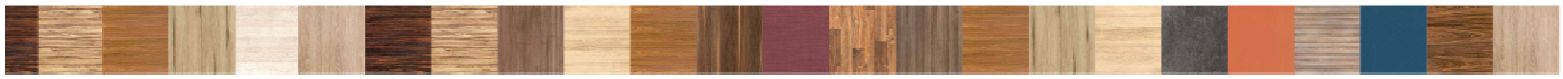
NATURAL ADHESIVE PRODUCTION & NAF

Market Issues.

• Today, NAF Market is an specific niche. It is demanded for Green Building certification and green markets in developed countries.

• In Latin America is not issue, as I formerly explained.

• Our studies indicate that the willingness to pay for a NAF board is no more than 30 % compared to an Standard MDF UF E1 board.



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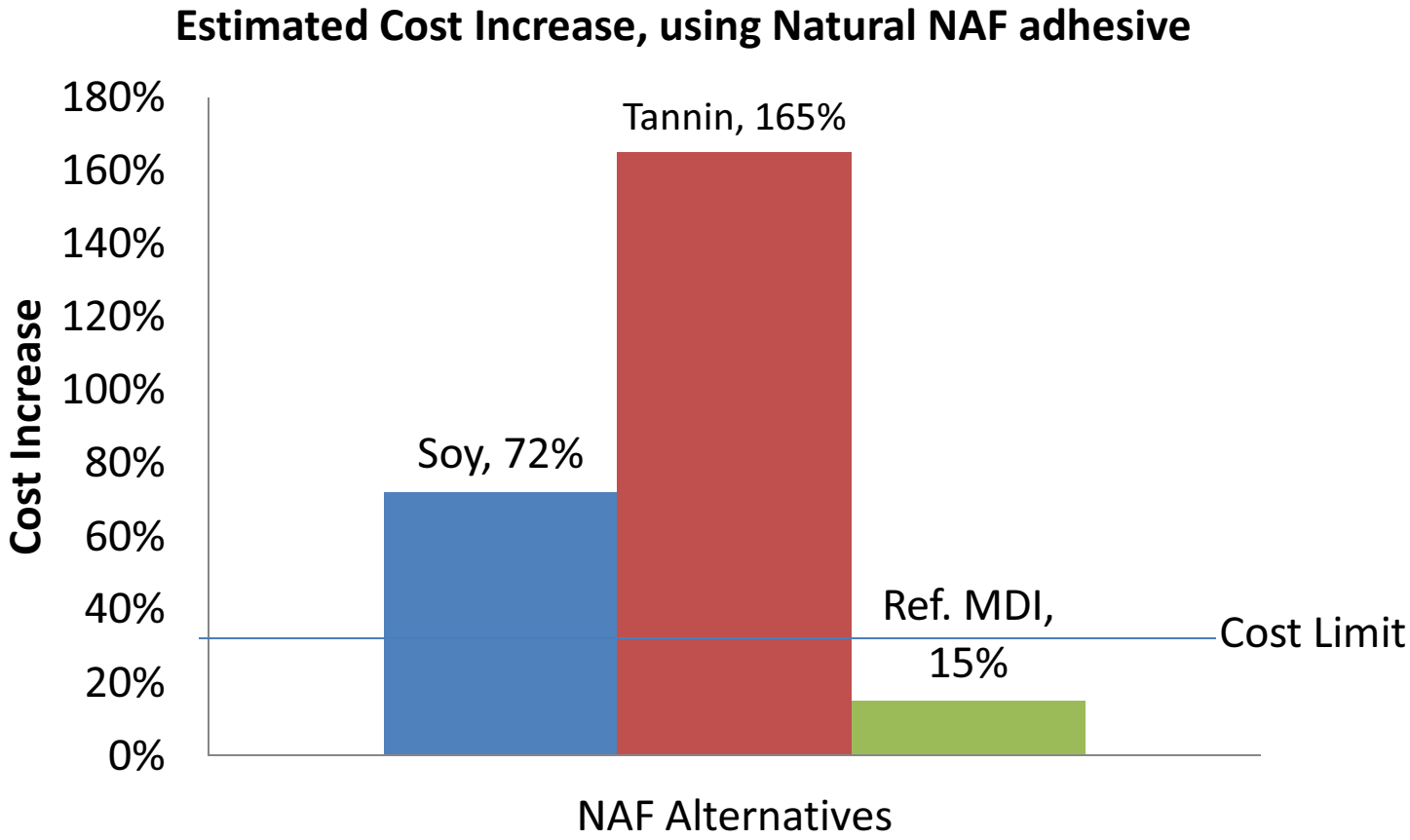


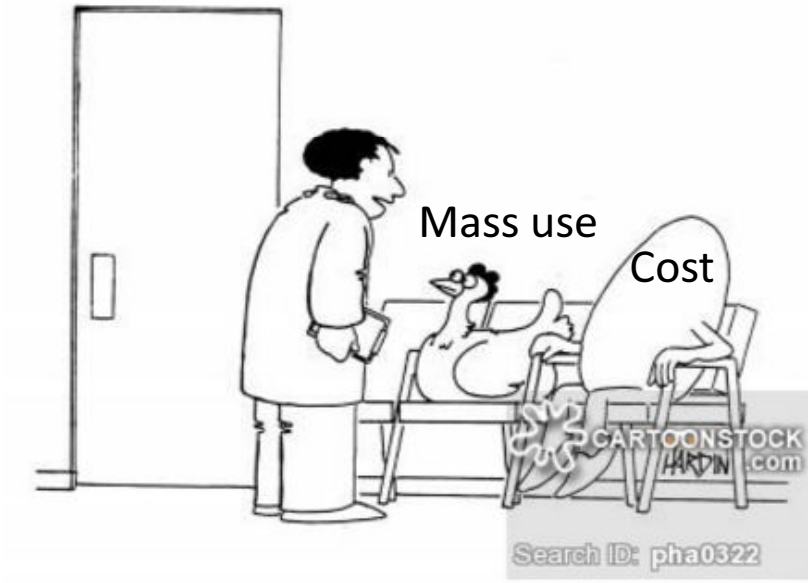
This is one reason to suppose that actually Natural NAF adhesive could not enter the Market, and MDI is the real industrial NAF adhesive alternative.

The opportunity is still there...

CONCLUSIONS AND NEXT STEP

• **UF or MUF adhesive :** Low emission products still have opportunities for research and optimize. Technology changes from the first high emission to actual low emission adhesive, (from customer point of view) were only incremental, but nothing disruptive happened. We need research on amino resins chemistry, for new development.

• Natural NAF adhesive : Our experience was this adhesives in general they work, but is necessary to reduce cost or increase the use to reduce cost. Today, the are no real economic alternatives.



CONCLUSIONS AND NEXT STEP

- **MASISA's Next Step.**

  • **Research** and test adhesives that replace formaldehyde by Glyoxal, with new catalysis systems (We are working with Georgia Pacific).

  • **Develop Hybrid adhesive : UF plus** (Georgia Pacific).

  • **In Natural adhesive**, try to reduce cost using flour directly (not a dispersion) in process , from soy or another vegetable protein source. (We are working with UBB : Universidad del Bío-Bío , and others).

  • **Exploring nanofiber** properties as adhesive additive to increase panel board properties and reduce adhesive consume . (Concepción University in MF and UBB in UF).

  • And more, by Open Innovation .

MASISA LAB

http://www.masisalab.com/

Industrial experience regarding natural and low emission adhesives.

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Thank you very much for your attention!