





The International Conference of the European  
Industrial Hemp Association (EiHA)  
May, 20-21<sup>th</sup> 2015, Wesseling, Germany



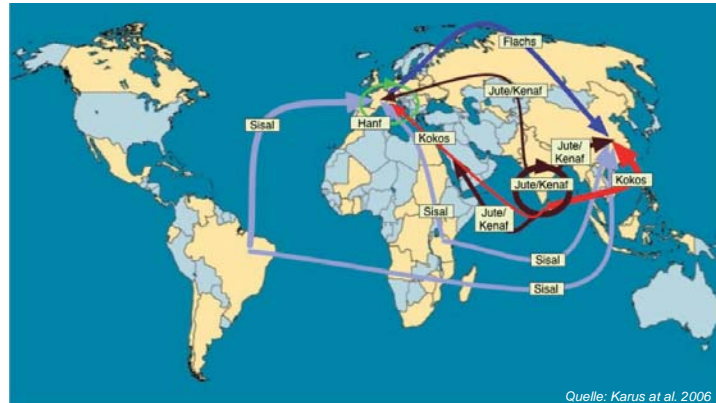
**FENAF – Summary from a 5-Year national research  
network on natural fibre supply chains**  
Dr. Hans-Jörg Gusovius \*  
Roman Rinberg, Torsten Brückner



## Outline

- Natural fibres – background
- A national network project – integrated cooperation
- Whole crop raw materials – from green flax to door trim
- Whole crop raw materials – exemplary wet preserved hemp
- Composite processing – novelty IMC
- Integrative manufacturing concept with NF
- Summary

## Flow of trades for natural fibres



- Natural fibres – an import commodity for German industry
- Global dependence from fibre supply
- Problematic security of supply

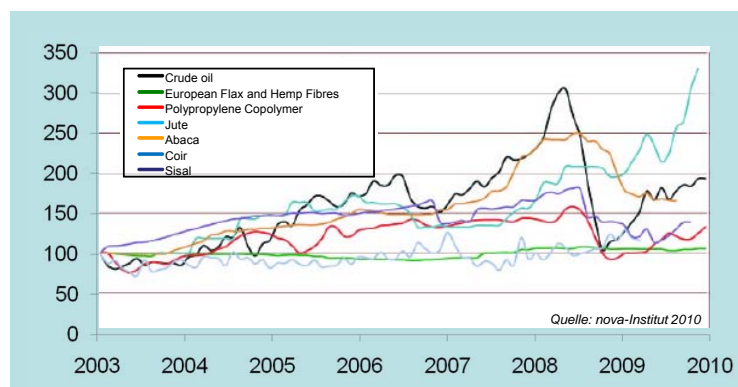


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## Price indices for natural fibres, crude oil and fossil based PP



- High price stability of European hemp and flax fibres
- Considerable weather dependence of harvest and, thus fibre supply
- Main supplier in Europe: France and Belgium



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## Motivation for the utilization of “the whole plant”

- Enhancement of material and cost efficiency of natural fibre reinforced composites
- Utilization of economical sustainable natural fibre raw material from domestic origin
- Integrated process chain from the plant/crop to the product

### Ganzheitliche Bereitstellungs-, Verarbeitungs- und Fertigungsstrategien von **NaturFAS**errohstoffen

Integrated Supply-, processing and manufacturing procedures for natural fibre raw materials

15 partners from agriculture, industry and science



aufgrund eines Beschlusses des Deutschen Bundestages



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## Overall goals



### Short-term

- Identification of deficits in common supply and process chains
- Definition of requirements for raw materials, semi-finished as well benchmark products

### Medium-term

- Material- and procedure development based on practical component requirements
- Establishment of competitive domestic raw material resources
- Development of innovative product applications with high market potential
- Commercial realisation of novel manufacturing processes with natural fibres

### Long-term

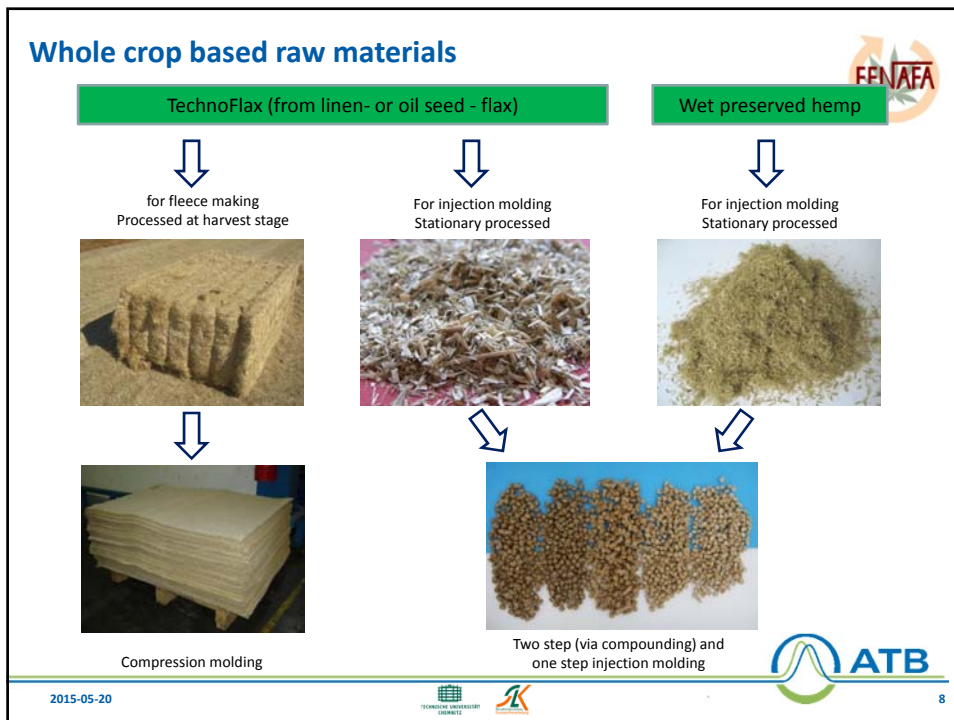
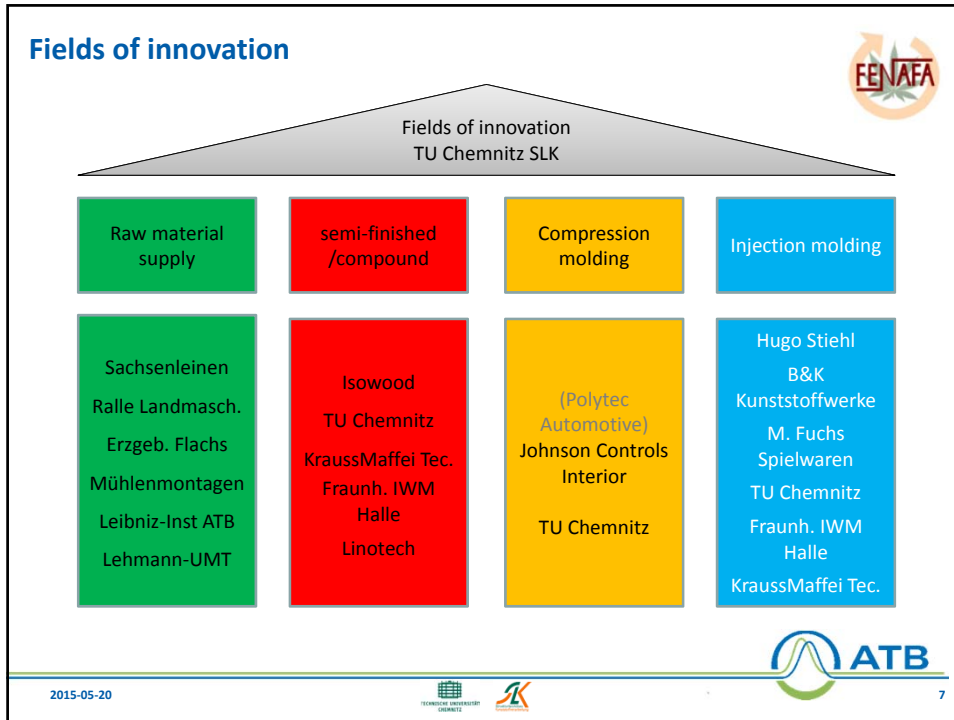
- Value-added by material and cost efficient production in fields of:
  - Supply of sustainable economic fibrous raw materials of domestic origin
  - Introduced consumer goods
  - Technical applications





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### Whole crop raw material "TechnoFlax"



Pulling

↓

Field drying  
(no retting)

↓


De-seeding and  
turning



↓

Field drying  
(no retting)

↓


Stem shortening and  
baling





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↓

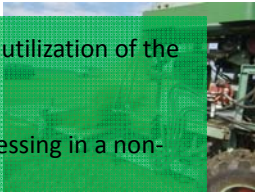
turning

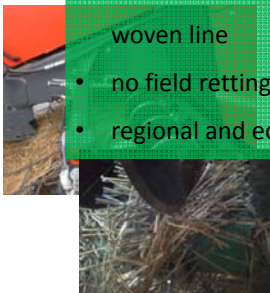

↓

Field drying

↓

Stem shortening and  
baling




- no separation between fibre and shive: utilization of the „whole crop“
- no stationary decortication: direct processing in a non-woven line
- no field retting, reduction of weather related risk
- regional and economically feasible

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### Whole crop based needle felts

**“TechnoFlax” bale**

**Bale opening, mixing, “lin opener”**

**Felt making**

**Needle punching**

**Semi-finished mat**

Thermoset matrix:  
100% green flax mat

Thermoplastic matrix:  
hybrid green flax mat with polypropylene

Arreicherung von Flachschäben an der Mattenunterseite  
-10 mm  
Herstellung von Flachschäben

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**ATB**

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• Quick / short-termed availability of the raw material (regional supply, short transport distances)






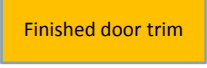
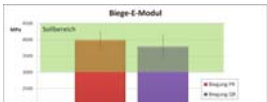
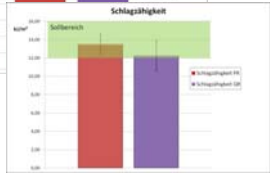
• Reduced stock keeping

• Cost advantage / stable prices

=> Potential / field of application for (green) TechnoFlax are valid !!




### Whole crop based door trim


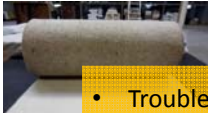



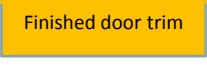
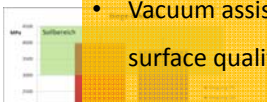

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### Whole crop based door trim











- Trouble-free processing of the component with optimized mat recipes
- Homogeneous deformation attitude
- Comparable characteristics to state-of-the-art
- Vacuum assisted lining with TPO foam layer possible – improved surface quality important

**=> High realization potential for interior components**


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### Whole crop based value added chain




Process step	Standardized material and processing costs	
	Conv. NFC	NFC with TechnoFlax
Raw material	100 %	35 %
Semi finished mat	100 %	67 %
Door trim with PUR matrix	100 %	85 %



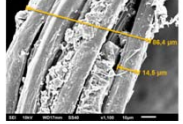


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### Whole crop raw material from wet preserved hemp

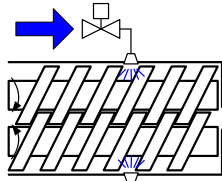


**1 Wet preservation**

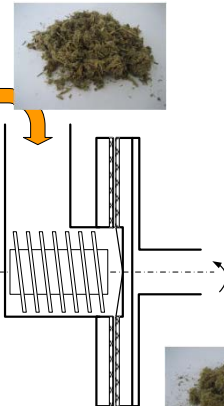

raw material

**2 Extruder**





steam

**3 Disk Mill**

milled plant fibre  
(drying  $\phi \approx 50 \dots 60 \% \rightarrow \phi \approx 10 \dots 15 \%$ )





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### Further processing to composites

#### The Injection Molding Compounder

**Add-on:**  
 New volumetric and gravimetric dosage device for non free flowing (fibrous) materials

- Patented
- Manufactured by ULT GmbH
- Combination with IMC successful

Less component costs (less process steps)

Higher fibre length (better mechanics)

Gentle processing ("one heat", no drying)

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### Processing with IMC: selected results

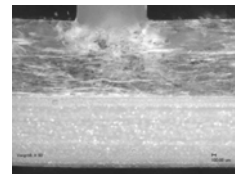
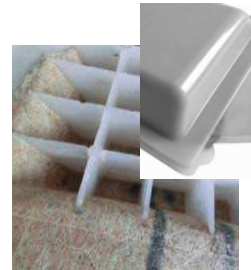
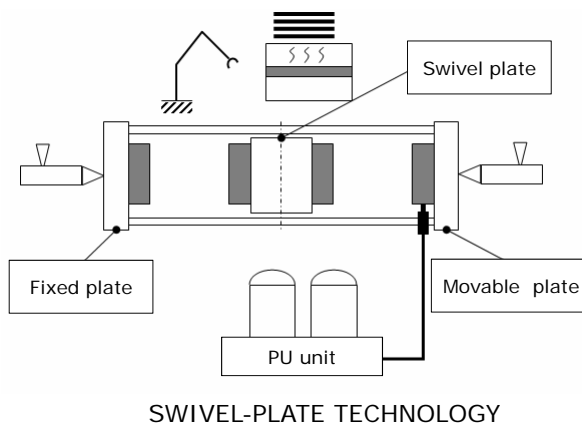
Material	Tensile Young's Modulus [MPa]	Tensile strength [MPa]	Charpy-Impact strength at room temp. [kJ/m²]	Charpy-Impact strength at -20°C [kJ/m²]
TechnoFlax	1970	21,5	8,16	6,47
Wet pres. hemp	2430	26,9	11,35	8,49

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### Integrative manufacturing concept with NF



- Efficient manufacturing technology
- Surface finished light weight components (soft-touch- or varnished surface)
- High natural fibre content
- Integrated functional elements (retainer, clips, retainer etc.)



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### Whole crop based consumer goods



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## Summary



- Regional supply chains for domestic fibrous raw materials are optimized
- Economical and technological feasible
- Integrated process chain for utilization in automotive applications is demonstrated and proven
- optimization of the process parameters and the screw configuration of the IMC for NF processing is realized (dosage, high friction and low heat stress)
- Products such as transport and storage boxes are produced on an industrial sized injection molding compounder
- Integrative manufacturing concept with NF by swivel plate technology
- supply and processing of “whole crop” raw materials on an industrial and an economic viable scale and respective characteristics of the products successfully transferred from research to practice

### ACKNOWLEDGMENTS

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## Thank you



Dr. H.-J. Gusovius  
Leibniz Institute for Agricultural Engineering Potsdam  
Department of Post Harvest Technology  
Max-Eyth-Allee 100 / 14469 Potsdam-Bornim /  
GERMANY  
phone/fax: ++49-(0)331-5699-316 /-849  
email: [hjgusovius@atb-potsdam.de](mailto:hjgusovius@atb-potsdam.de)  
url: <http://www.atb-potsdam.de>

Dr. Roman Rinberg  
Technical University Chemnitz, Department of Lightweight  
Structures and Polymer Technology, Germany  
Torsten Brückner  
SachsenLeinen GmbH Waldenburg, Germany



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