Pelletizing different raw materials: findings from research that can be valuable

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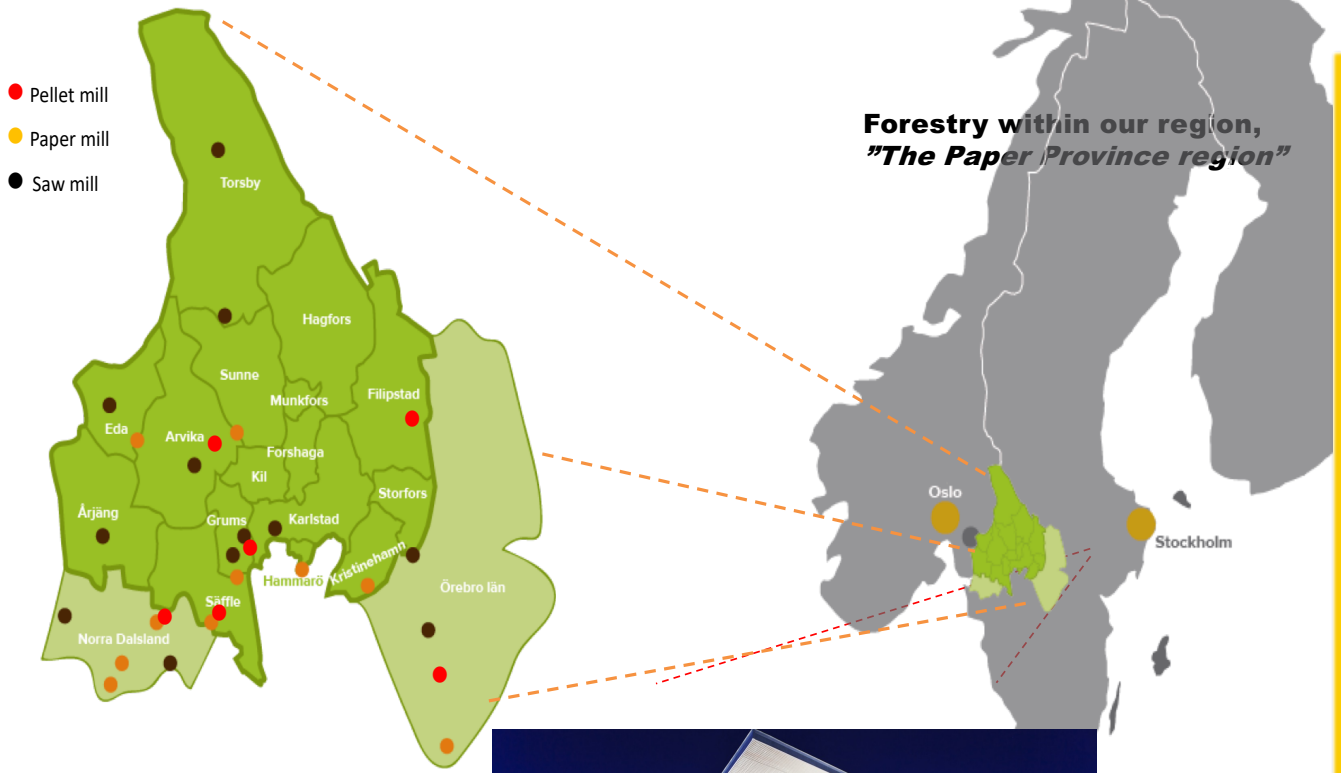
WBA Webinar Series – Advanced Biomass Cooking
Pellet plants in developing economies: Experiences of project developers
12th April 2022 (Tuesday)
15.00 CEST / 18.30 IST / 13.00 GMT / 09.00 ET

Karlstad University, Sweden



- Karlstad – population 95 000,
  County seat of Värmland, Sweden.
- Värmland is a forestry region with many pulp and paper mills and even more sawmills and a number of pellet plants
- Karlstad University is located between the capital of Sweden, Stockholm, and the capital of Norway, Oslo
- One of the youngest universities in Sweden, inaugurated in 1999
  19 000 students
  1 300 staff
- Education and research in cooperation with external partners

Pro2BE

RESEARCH ON PROCESSES AND PRODUCTS FOR A FOREST BASED CIRCULAR BIOECONOMY

Karlstad University have equipment and knowledge to broaden the raw material base from residuals from the forest industry and from agricultural residues that promotes a transition to a Circular Bioeconomy.

Pro2Be

Research areas

- Drying and Dewatering
- **NewDePT**, New Development and Processing for Pellet Technology
- Functional Surfaces and Sustainable Materials
- Water energy nexus
- Packaging for a Sustainable Development
- Fundamental Separation Science Group

NewDePT

Jonas Berghel
Research leader
NewDePT

Stefan Frodeson

Magnus Ståhl

Gunnar Henriksson

Lars Pettersson

Workson Siwale

Carina Rehnström

NewDePT - Vision and research field

The research comprises how renewable materials can become a high-quality pelleted product, in a sustainable and energy efficient way.

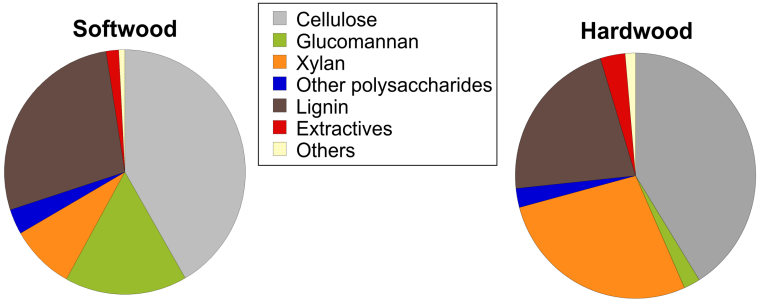
NewDePT are strongly connected to

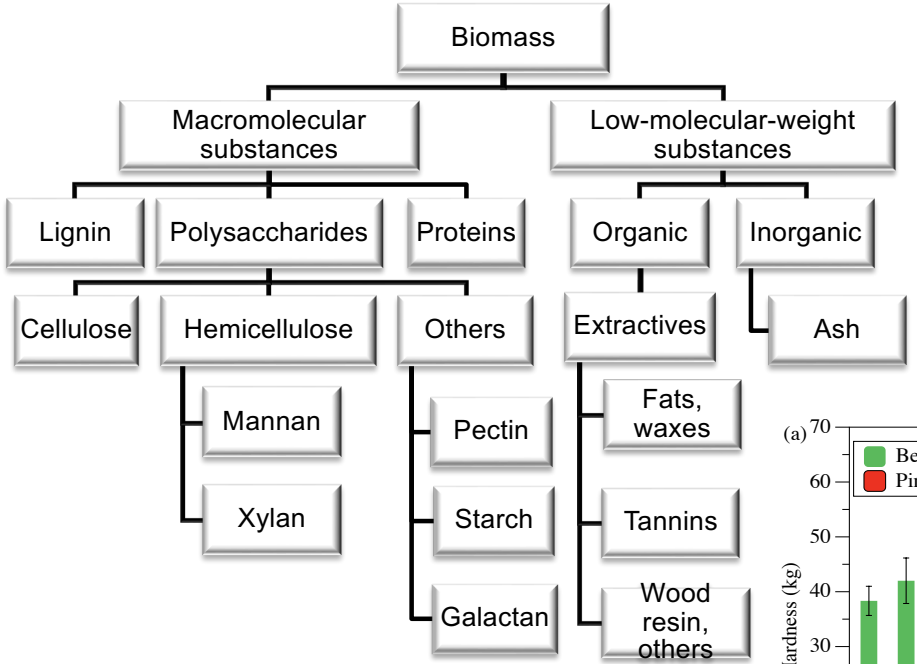
- Fundamentals and Applications, Mechanical processes and Wood Chemistry.

Focus of research are:

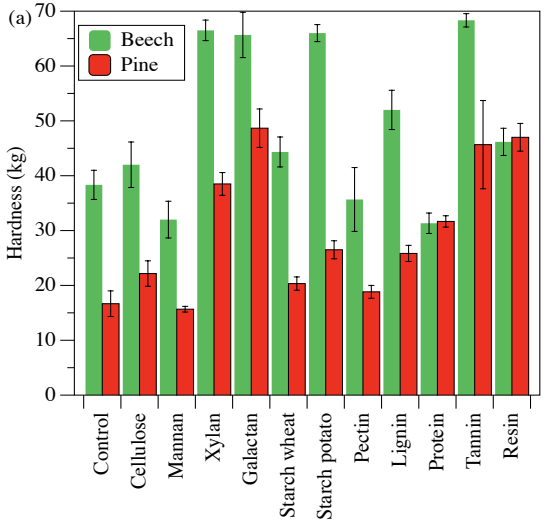
- **Effect of Different Wood substances**
- Energy efficiency
- Self heating/off gas during storage
- Effect of bio-based additives
- Quality aspects
- New materials

Effect of different wood substances





There is also a great variety in different parts: heartwood, sapwood, top and branches,



More results are presented in article;

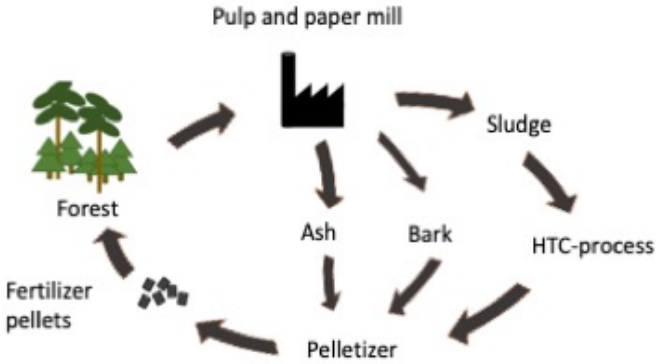
Densification of Wood—Influence on Mechanical and Chemical Properties when 11 Naturally Occurring Substances in Wood Are Mixed with Beech and Pine. Frodeson, S., Anukam, A.I., Berghel, J., Ståhl, M., Lasanthi Kudahettige Nilsson, R., Henriksson, G., Bosede Aladejana, E., 2021. Energies, 14, 5895.

Ongoing external research projects

1. **Svinpels -** Safe and well-characterized raw material and product by innovative new process customization with the help of spectroscopic methods and controlled sawdust maturation at pelleting. *Swedish University of Agricultural Sciences and Karlstad University*
2. **InnoPels -** Increased resource efficiency through innovative new raw material handling in the production of fuel pellets. *Swedish University of Agricultural Sciences and Karlstad University*
3. **BioSirk,** Life cycle optimized processes for value creation with wood materials. Interreg. *Karlstad University and OsloMet*
4. **NärSkog 2,** Enriched biochar from forest industry residues for fertilization of plants and forest land. *Karlstad University*

Internal research projects

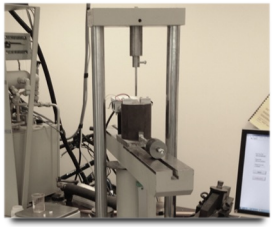
1. Improved understanding of the pelletizing process – from pure substances to separated and analysed wooden parts.
2. SPP, single pelletizing process, energy, material and scale effects.
3. New raw material and test bed for cooking stoves, Emerging cooking solutions.



Testbed and pellet equipment in three scales

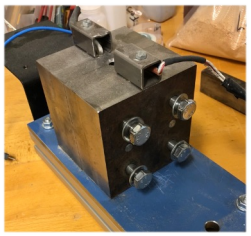
1. Single pellet press (SPP)

- 1-3 g/test
- Small amount of raw material needed
- Three types (A-C) of SPP



A)
Study of compression and friction
Batch testing

B)
Study of compression, flow and friction
Batch testing and continuous



C)
Study of the springback effects of the pellet

2. Bench scale

- < 20 kg/hour
- 10-20 kg raw material/test series

Easy to variate materials and study raw material's possibilities to be pelletized. Example of parameters that can be variated are press lengths, optimal moisture content and particle sizes.

3. Small industrial plant

- < 300kg/hour
- 50kg -1 ton of raw material/test series

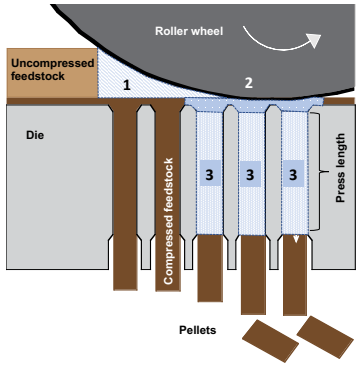
During full production we can study and variate parameters such as adding additives and/or steam, mass flow rate, temperatures and raw material mixtures under controlled forms

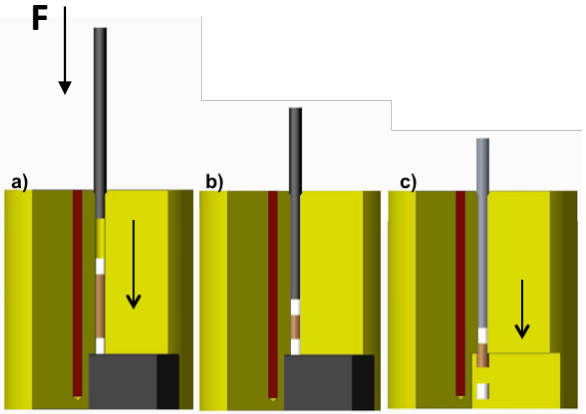
The Biomass Processing Factory

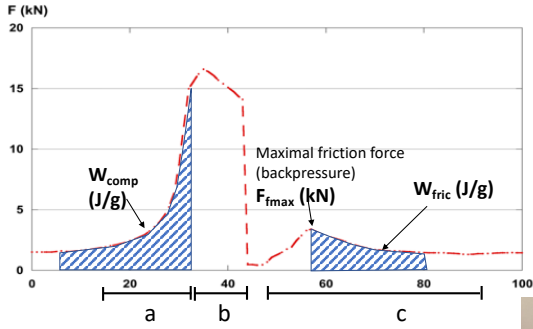
Single pellet presses

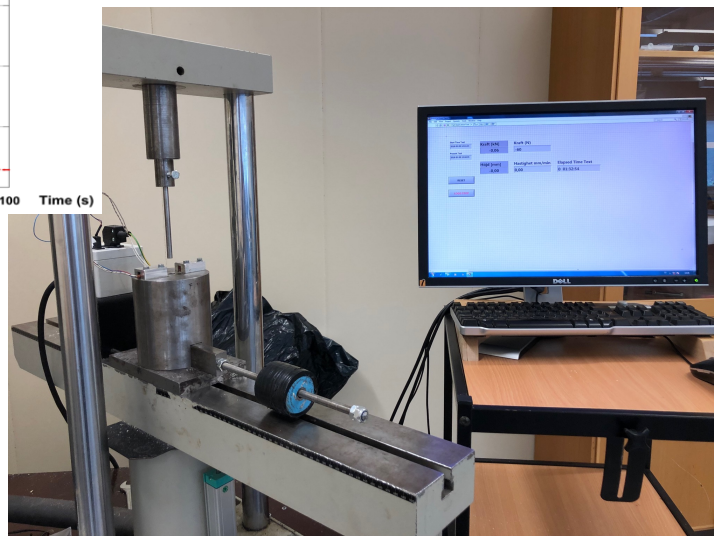
Three different presses to study:

1. Compression and friction
2. Compression and "springback"
3. Compression, "flow" and friction



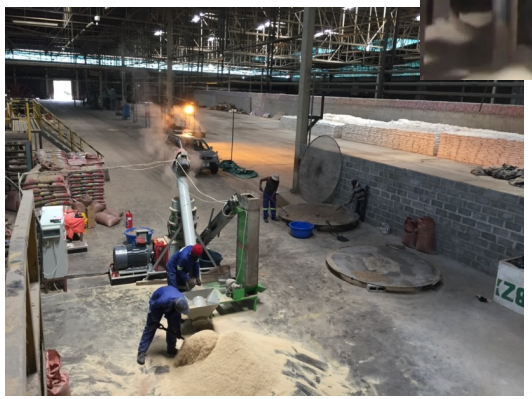






Pellet production in Zambia

Logistics are done with muscle power

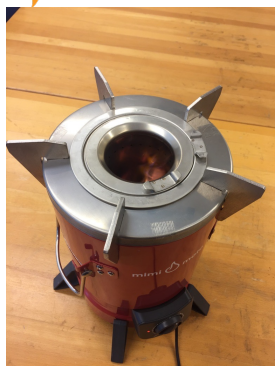


The process of feeding including mixing for the right moisture content and cooling by placing hot pellets on a "cooling net"

Pellet production in Zambia towards sustainable development

Cooking solution replacing charcoal
- reduces deforestation, improves the indoor climate and creates jobs and local growth

emerging cooking solutions



Problems to handle
- build pellet factories with good infrastructure
- various raw materials
- uneven electricity supply
- need of knowledge, experience and domestic data

Master and Bachelors thesis
in collaboration with Emerging Cooking Solutions (2017-2022)

- Evaluation of different hard wood species from Zambia to produce fuel pellets for cooking purposes, Annika Silvennoinen.

- Evaluation of potential biomass from Zambia for production of fuel pellets Production in a single pellet press, with associated friction and compression studies with hardness test and moisture uptake, Lisa Henriksson.

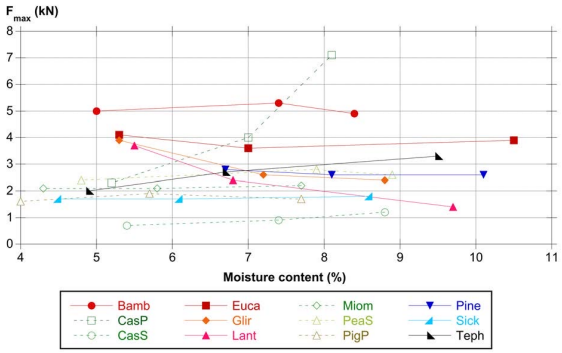
- Pellet Production of Sicklebush, Pigeon Pea, and Pine in Zambia, Simon Andersson.

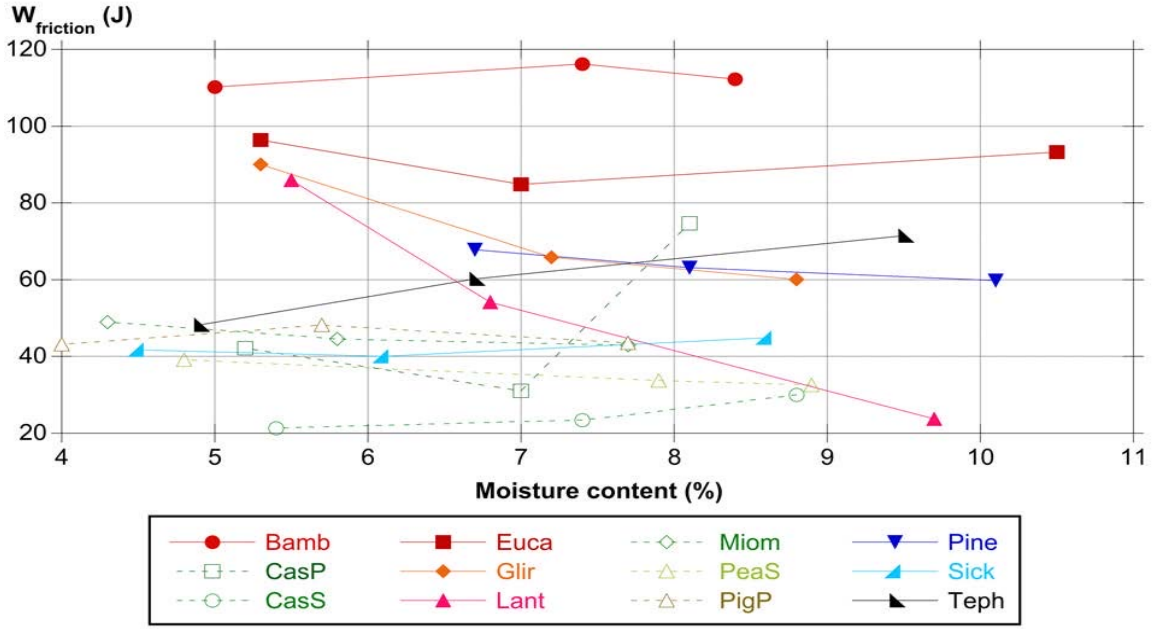
- Particle size impact on energy and quality when pelletizing nuts and shells, Sebastians Gisele, in Swedish.

- Evaluation of Zambian biomass to investigate its potential to be used as a raw material base in pellet production, Johan Söderkvist, in Swedish.

Searchable on *www.diva-portal.org*

Pellet production in Zambia towards sustainable development





Conclusion

One raw material cant serve the pellet plant mixes is needed

Eucalyptus, miombo, peanut shell, pigeon pea, and sicklebush could be combined in raw material mixtures for pellet production.

Further work - Collaboration

Apply for research funding's together to finance testing, PhD-studies and research work.

Create interesting projects for Master and Bachelor thesis at Kau

Contact us at NewDePT (*https://www.kau.se/en/environmental-and-energy-systems/forskning/newdept-research-pellet*)

Our goal is to increase the knowledge on pelleting in developing countries, including pellet raw material studies, studies of the pelleting process, and LCA and system analysis of the use of biomasses for pellet production

How it could work:

- materials are sent to Kau
- studies at SPP level
- studies of material properties, moisture content, pelletability, etc.
- test of cooking stoves according to standards
- recommendations made for manufacturing on site

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