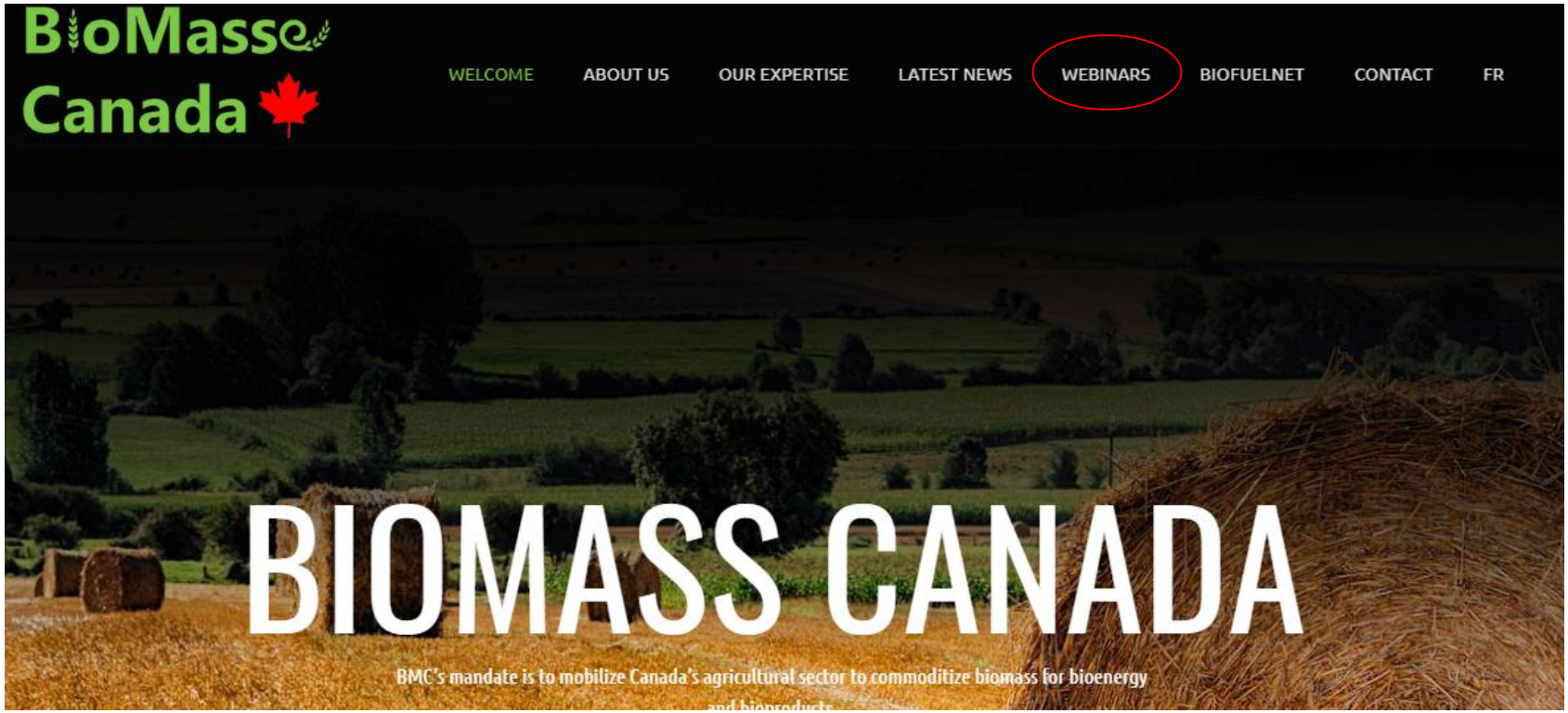
Biomass Canada Cluster Webinar Series

“De-risking and commoditizing underutilized biomass resources: Facilitating the evolving Canadian bioeconomy”



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Biomass Canada Cluster

- Led by the BioFuelNet Canada Network with the financial support from Agriculture and Agri-Food Canada's AgriScience program and industry partners
- Overall objective: Enhance the contribution of Canadian agriculture into the growing Canadian bioeconomy
- The cluster is comprised of 10 activities with the aim of improving technologies for producing, processing and distributing feedstocks from agricultural biomass, for low-carbon bioenergy, biofuels and other bio-based products.

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Housekeeping

- The webinar is being recorded and a copy of the recording and slides will be posted on Biomass Canada website: https://biomass.biofuelnet.ca/

- Please type your questions into the Q&A box. We will try to answer as many questions as possible.

- Please type your name and affiliation in the chat box.

Biomass and Bioenergy Research Group (BBRG)

BBRG is made up of a core group of engineers and scientists focused on **turning raw biomass into industrial feedstock** that would meet the requirements of bio-industries.

BBRG main technical activities: biomass size reduction, dehydration, densification, and best practices for safe handling and storage of biomaterials.

BBRG has a unique expertise in developing mathematical models for conducting feedstock supply chain simulations and techno-economic assessments.

Development of logistics, pretreatment and commercialization of agri-pellet

Dr. Shahab Sokhansanj
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University of British Columbia

In Partnership with

Biomass Cluster holder: BioFuelNet Canada
Wood Pellet Association of Canada (WPAC)

Funded by

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MAKE A CASE

- Global demand for wood pellets has been constantly growing in the last decade and it is projected to keep growing with the increased number of heat and power decarbonization policies.

- Between 2012 and 2018, the global wood pellet market has experienced growth rates averaging 11.6% annually, from about 19.5 million metric tonnes in 2012 to about 35.4 million metric tonnes in 2018.

- The limited availability of sustainable forest biomass resources will increase the demand and global trade of other biomass resources such as agricultural residues.

- Despite the commercial production of agricultural biomass in Canada, in particular Canadian Prairies, there is no use of agricultural biomass for bioenergy in Canada.

- The increase in the use of agricultural biomass requires converting bulky ag biomass into dense products such as pellets with consistent quality.

Pelletized biomass has logistical advantages over other forms of solid biomass for transport and storage

(pelletized biomass fits well to the Canadian production and distribution)

1. **Logistics** - Optimize the integration of biomass resources and logistics to establish cost, energy input, CO2 emissions for pellet enterprises. Dr. Mahmood Ebadian
2. **Quality** - Develop commercial grade pellets in support of commercialization of agri-pellets. Dr. Hamid Rezaei
3. **Storage** Develop best practices and standards to minimize the degradation of biomass pellets during storage, handling, and transport. Dr. Fahimeh Yazdanpanah

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Evaluate the economic viability of agri-pellets production using mobile pellet units

Dr. Mahmood Ebadian

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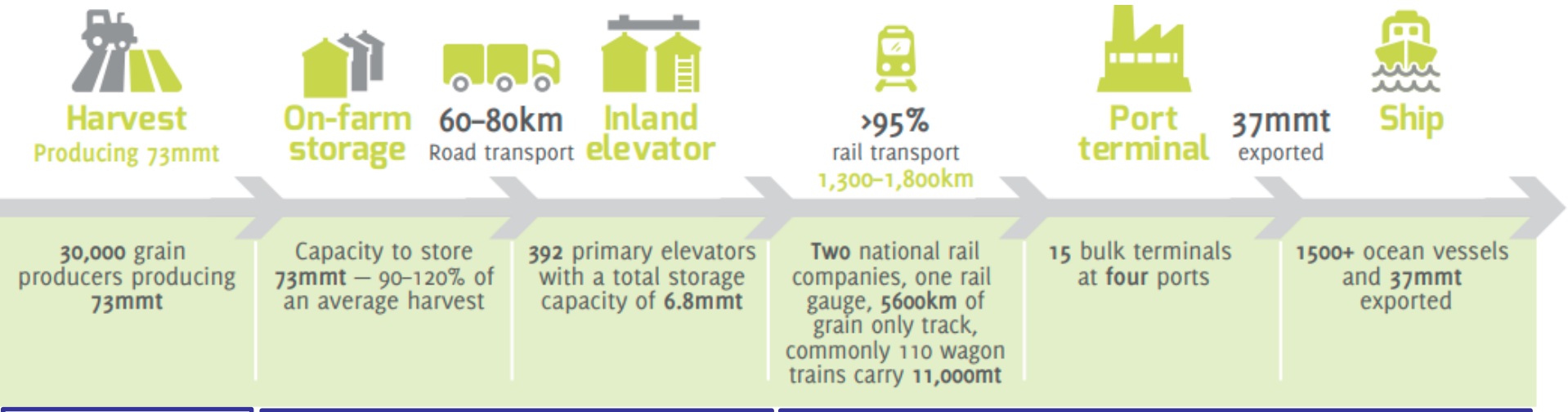
Potential integration of agri-pellets supply chains with well-established grain supply chains in Canada



Produce ag-pellets at the farm-side using a mobile pellet unit, similar to existing custom combine and baling operations

Store, transport and handle ag-pellets from farms to grain elevators, leveraging the existing grain storage, handling and transportation infrastructure

Distribute ag-pellets to local and domestic bioenergy, biofuels and other bio-based products markets

Rail transport and port storage and handling at port terminal, leveraging the existing rail and port terminal infrastructure in Canada

Distribute ag-pellets to regional and international bioenergy, biofuels and other bio-based products markets

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Demonstration of mobile ag-pellet unit in Alberta

Caith Cameron, co-founder of Four Peaks company, collaborating with the Westway Farms Ltd who operates a 7,500 acres of grain and hay along with 500 head of cow-calf operation, looking for diversifying the use of agricultural biomass

UBC-Biomass and Bioenergy Research Group recently purchased a mobile pellet unit from Sweden with a pellet production capacity of 150 kg/hr. The entire unit fits into a 20’ ft container.

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Other examples of mobile pellet units

- Prodesa (Spain/USA)
- Proxipel (Switcherland)
- Buskirk Engineering (USA)
- Vecoplan Midwest (Germany/USA)
- Metitron 560 (Germany)
- Schaider Pelletec D 8.0 (Germany)
- Premos5000, Germany
- GEMCO (China)
- Servoday (India)

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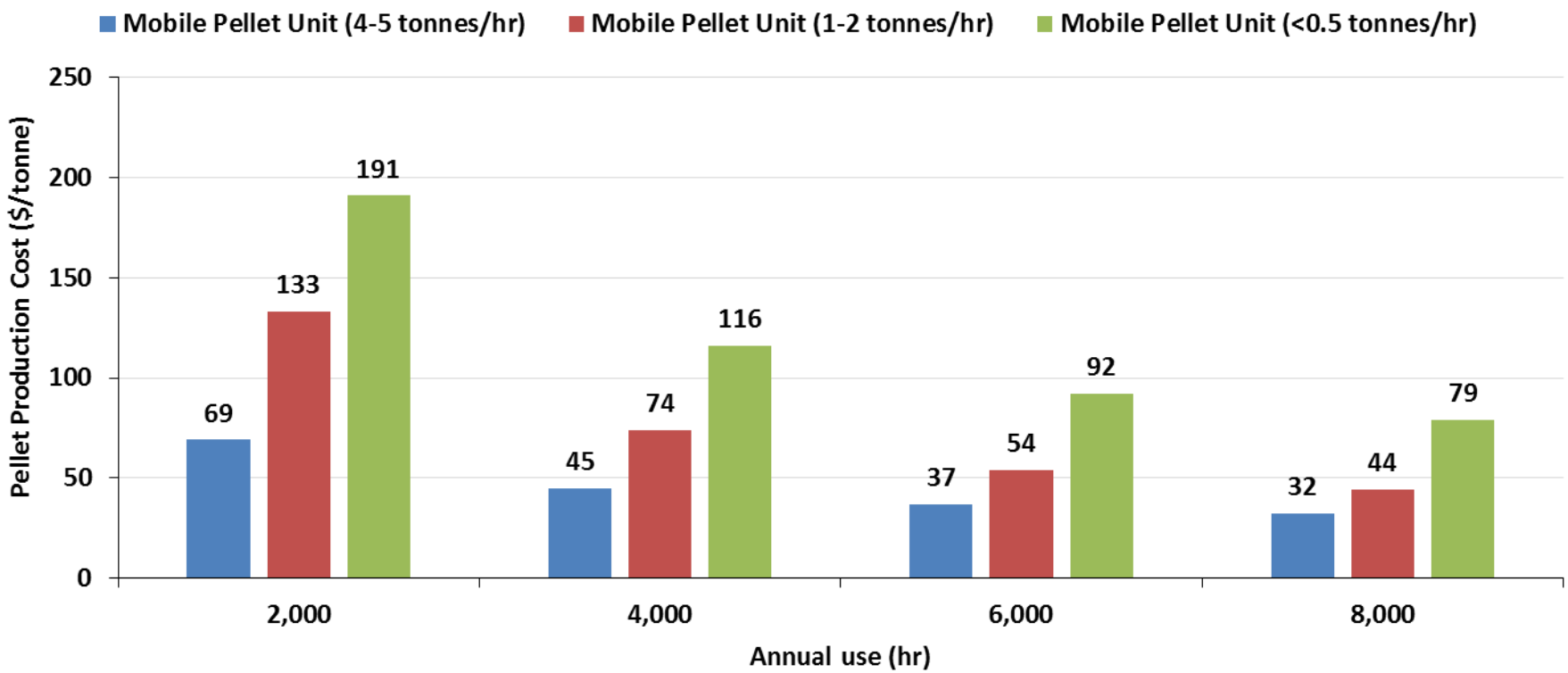
Capital cost and throughput of farm and farm-side equipment

Machinery	Capital Cost (CAD $)	Throughput (dry tonne/hr)	Annual Use (hour)
Baler and Tractor	75,000-350,000	15-25	150-500
Bale Collector	250,000-350,000	20-30	150-500
Loader/Telehandler	60,000-75,000	50-60	1000
Bale Grinder	55,000-350,000	3-15	200-1000
Mobile Pellet Unit	225,000-2,000,000	0.15-5	???

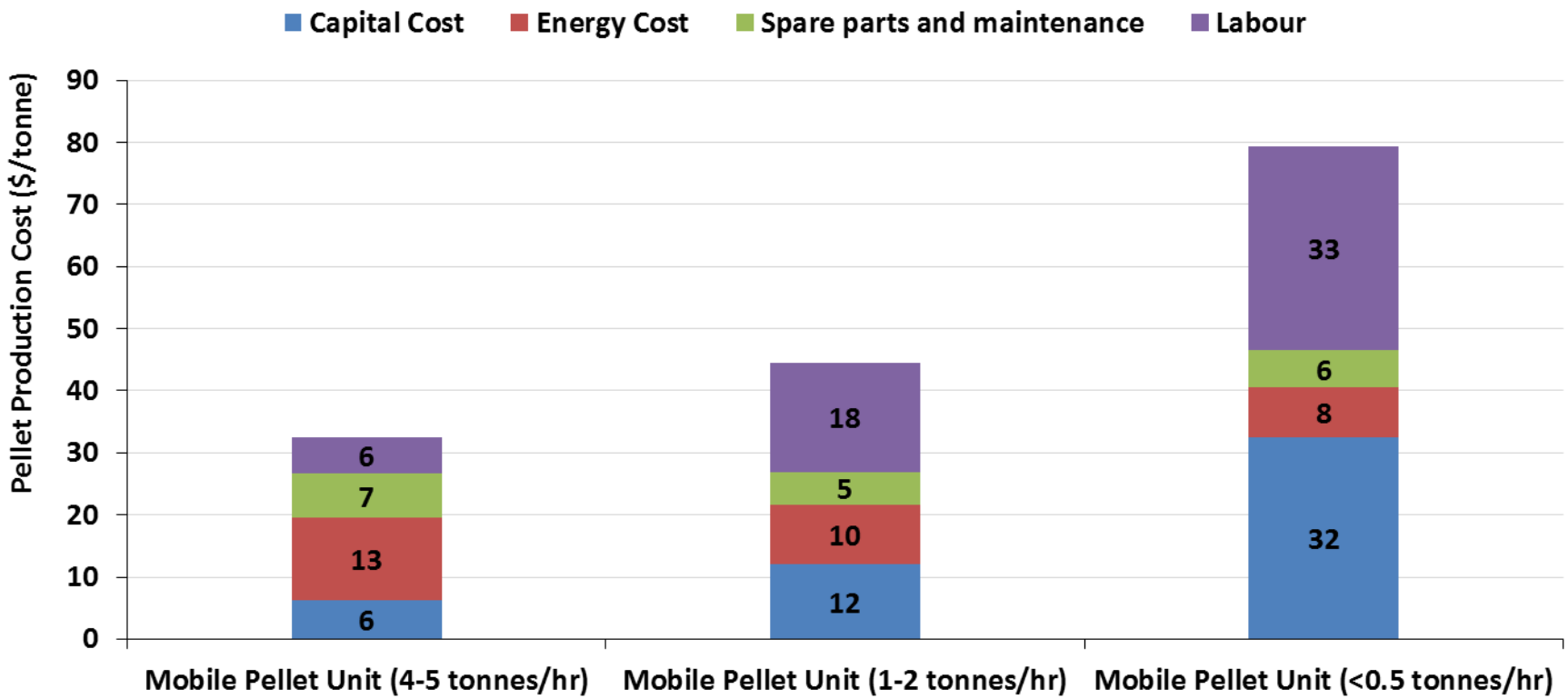
- One of the challenges of using small-scale pellet unit in a farm would be its small throughput compared to its preceding operations.
- Annual use of the pellet unit is critical to compensate for its small throughput. Thus, the pellet unit needs to be used year-round.

Cost of pellet production (feedstock is not included)



- **Assuming ag biomass is dry (no drying required)**
- **Increasing the annual use from 2000 hr to 8000 hr would reduce the ag-pellet production cost by 60%.**

Contribution of capital cost and operating costs to the pellet production costs in small pellet units



- Assuming 8000 hr/year of operations, one labour/unit
- About 30% of pellet production cost is capital and the rest is operating costs (i.e. energy, maintenance and labour)

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Conclusions

- **Use of mobile pellet units year-round is critical to produce ag-pellets at competitive costs**

- **The ag-pellet production cost is estimated to be in a range of $32-79/tonne with mobile pellet units with capacity of 0.15-5 tonnes/hr and annual use of 8000 hr.**

- **The production cost of ag-pellet using mobile pellet unit could be competitive with the wood pellet production cost which are in a range of $45-65/tonne.**

- **The location of the ag-pellet production operations can have a significant impact on the ag-pellet production cost. 55-60% of the production cost is associated with energy consumption and labor.**

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Collecting Agri-Pellet Production Data

Dr. Hamid Rezaei

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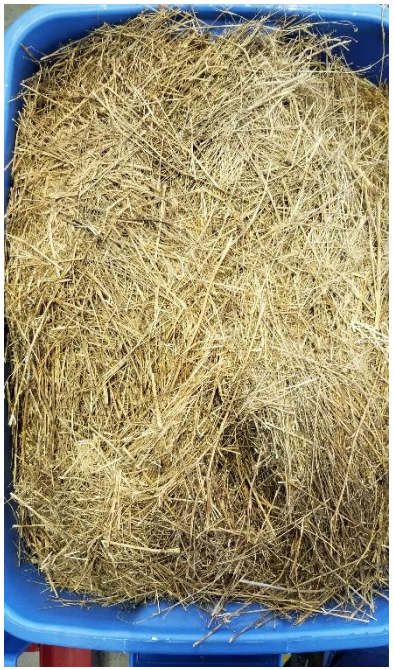
Barriers Against Commercialization of Agri-Products, Mainly Crop Residue

- Excessive ash content; biogenic and environmental
- Excessive Chlorine, K, in some cases silica
- Lack of lignin as a binder to make durable pellets without additives
- Variability in physical properties
- Challenges in industrial handling of agricultural biomass
- Ag-residues are often in baled and need to be de-baled.
- Ag-residues are difficult to grind, moisture interference.
- Little experience commercial handling of ag-material for pelletization and most of operations are farm based

Progress Report

- Assembled at least four species of biomass: corn stover, wheat straw, switchgrass and flax straw from various regions of Canada, ground these samples in a hammer mill and observed their grindability

Corn stover

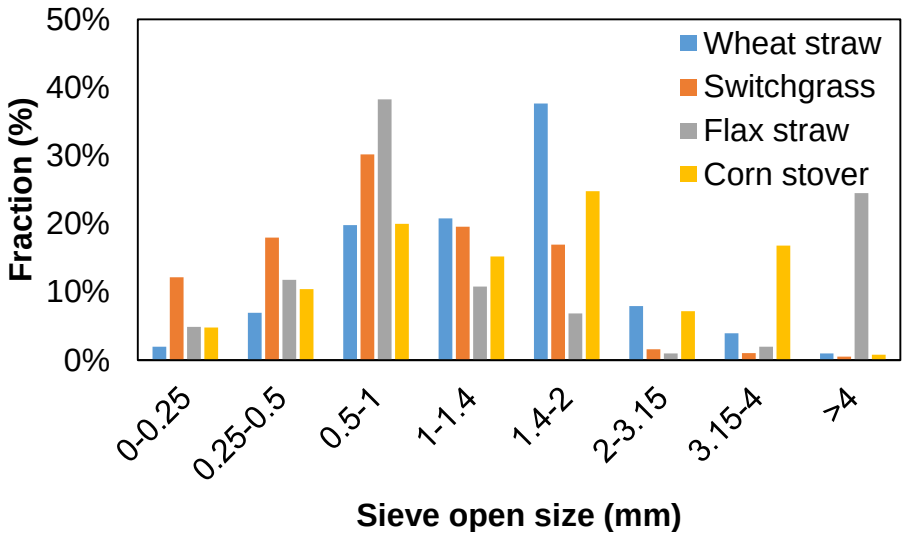


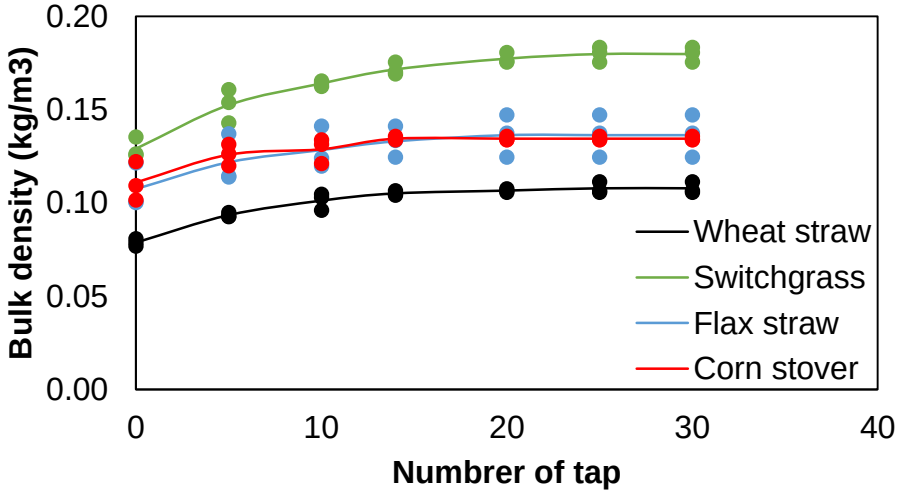
Flax straw

Switchgrass

Wheat straw

Physical Characterization





Switchgrass

Wheat straw

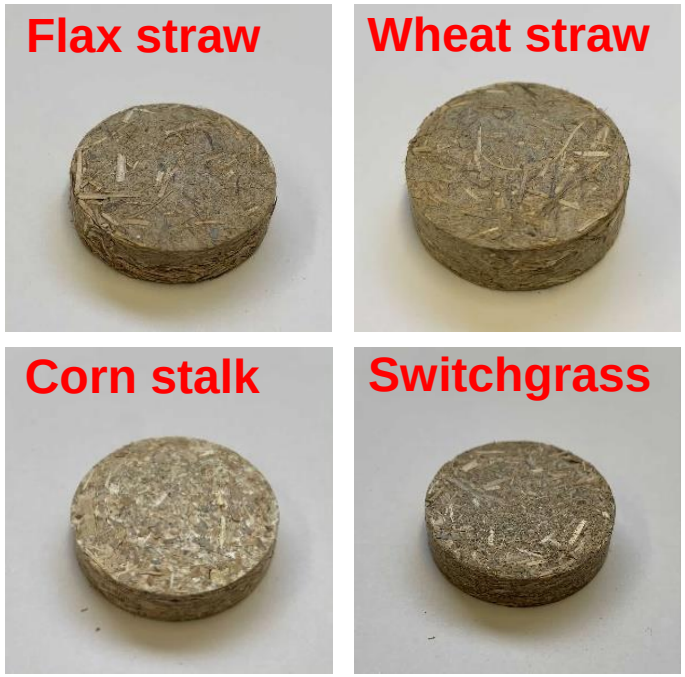
Flax straw

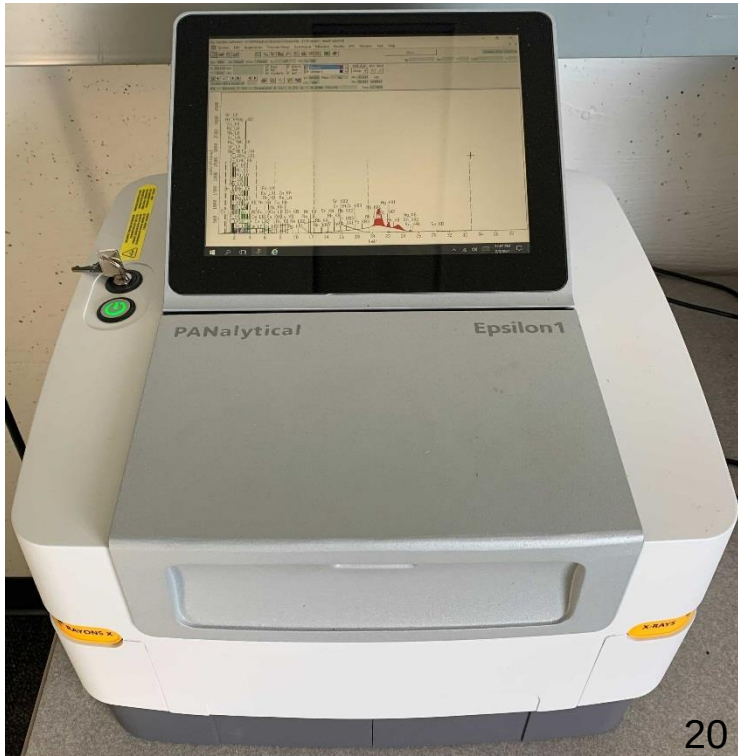
Corn stover

Flax straw fibers stuck in the grinder

Mineral Content

- We purchased one XRF unit to measure the Chlorine and salts in biomass.
- Mineral content is critical to show the biomass potential for power generation applications.
- Preliminary measurements were conducted to test and develop a standard operating procedure. The main measurements are under progress.





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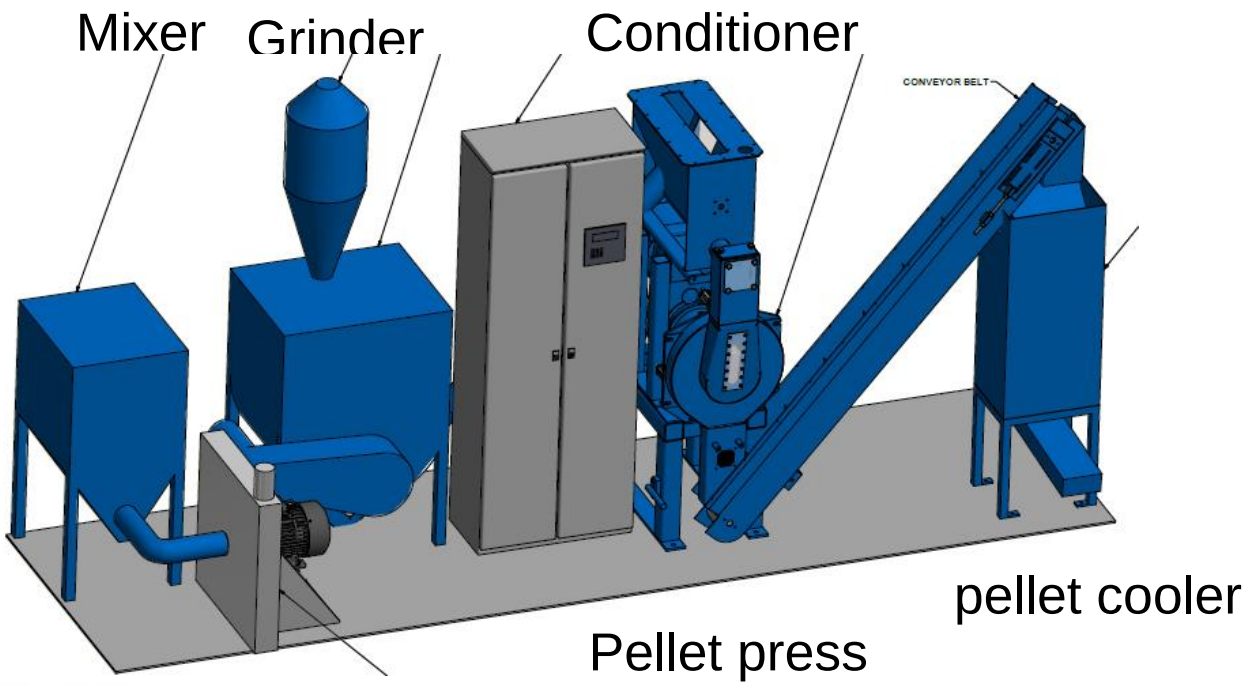
Mineral Content

- The measurements on high-chlorine content woody biomass proved the efficiency of washing and pressing in demineralization of biomass.
- The same procedure will be tested on ag-samples to meet the standard specifications.

Progress Report

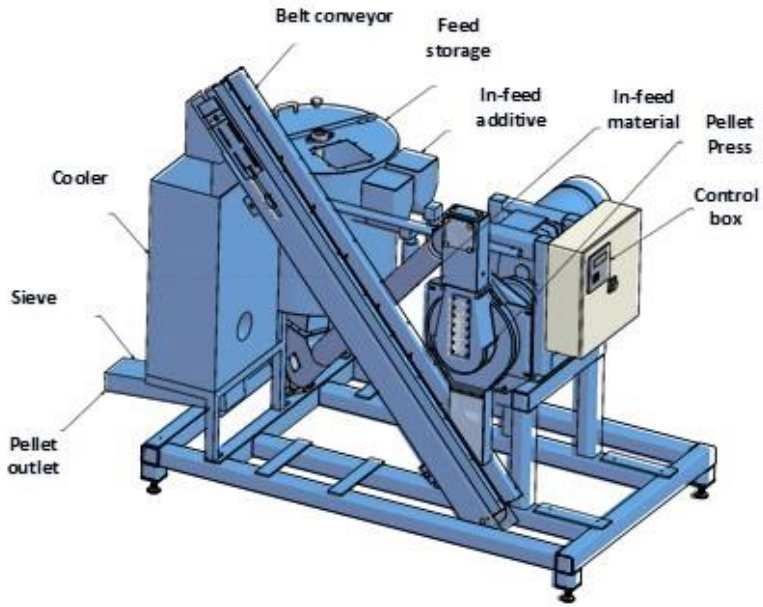
- Acquired a 150 kg/h pilot scale pellet mill from Sweden (SPC).
- We are in the stage of installation and troubleshooting. We will do initial testing at university.



Mobile pellet plant in the container

Next Steps

- Proposing and design an efficient size reduction method for ag-residues
- Show the effect of washing on ash reduction
- Test the effect of steam conditioning as a way of minimizing variation in biomass for pelletization.
- Optimize the production of ag-pellets in the new PP150 unit



Safe Storage and Handling of Commercial Biomass Pellets

Pellet quality throughout the supply chain and compliance (standard development)

Fahimeh Yazdan Panah

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Director of Research and Technical Development, Wood Pellet Association of Canada

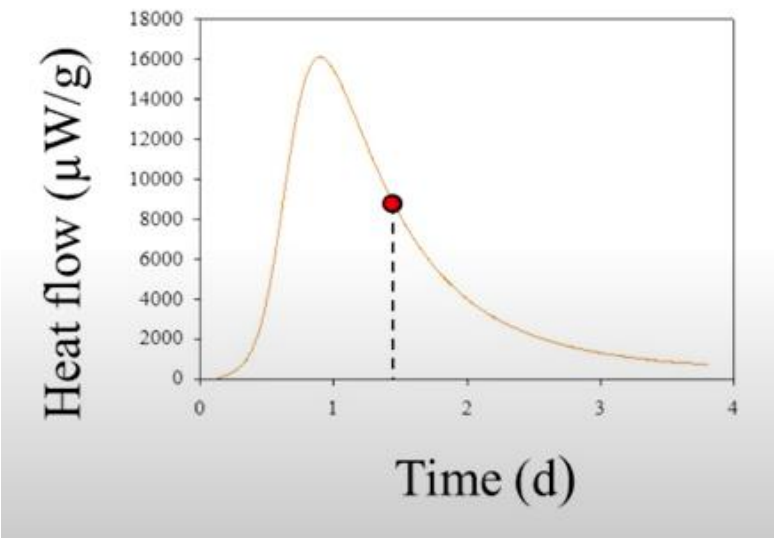
Research Associate, University of British Columbia

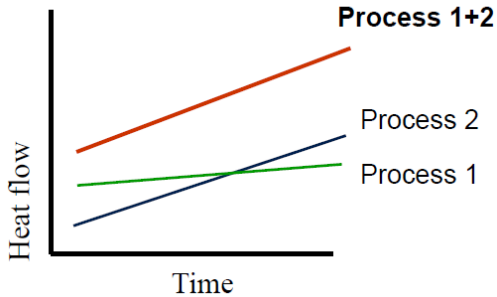
Approach & Technical Progress

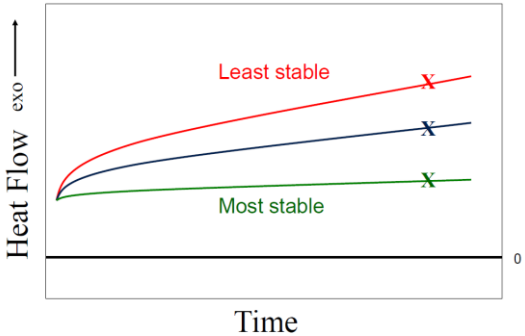
- Storage is a critical factor in commercial ag pellet production and use as the seasons are short
- Self-heating, off-gassing and oxygen depletion are determinants for Safe storage of biomass pellets
- Reactivity and gas emission measurement are done using special analytical equipment
- Development of methods to measure agricultural pellet properties and their compliance with the international standards

Biomass Pellet Storage Study: Reactivity

- Reactivity represents the amount of heat released during storage
- Calorimetry is sensitive to all physical and chemical processes associated with a heat flow. Thus, the monitored heat flow may contain contributions from several processes.







Biomass Pellet Storage Study: Reactivity

- Spontaneous heat generation from ag-residue pellets (any process/reaction. e.g oxidation, water uptake, biological, etc.)
- Data is associated with the specific quality and age of the sample material (e.g type and age of ag-residue).
- Test and compare for heat of reaction release over time.
- Heat flow is proportional to the rate of the exothermic reaction.

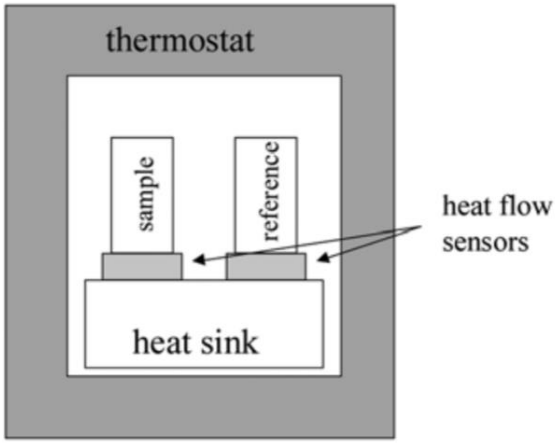
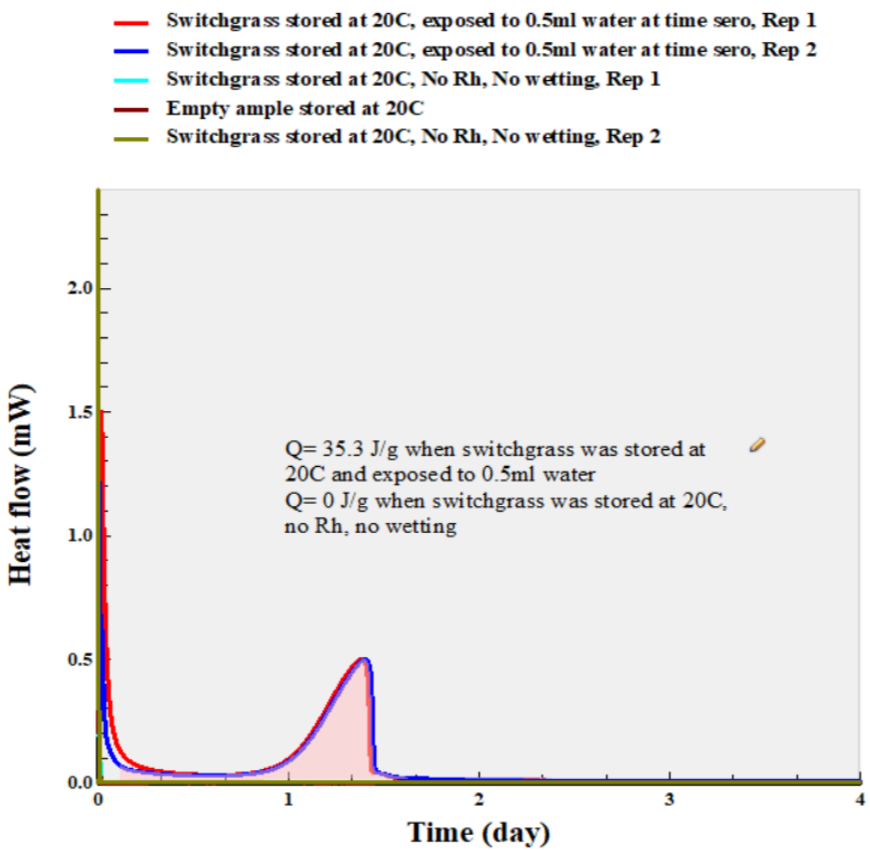
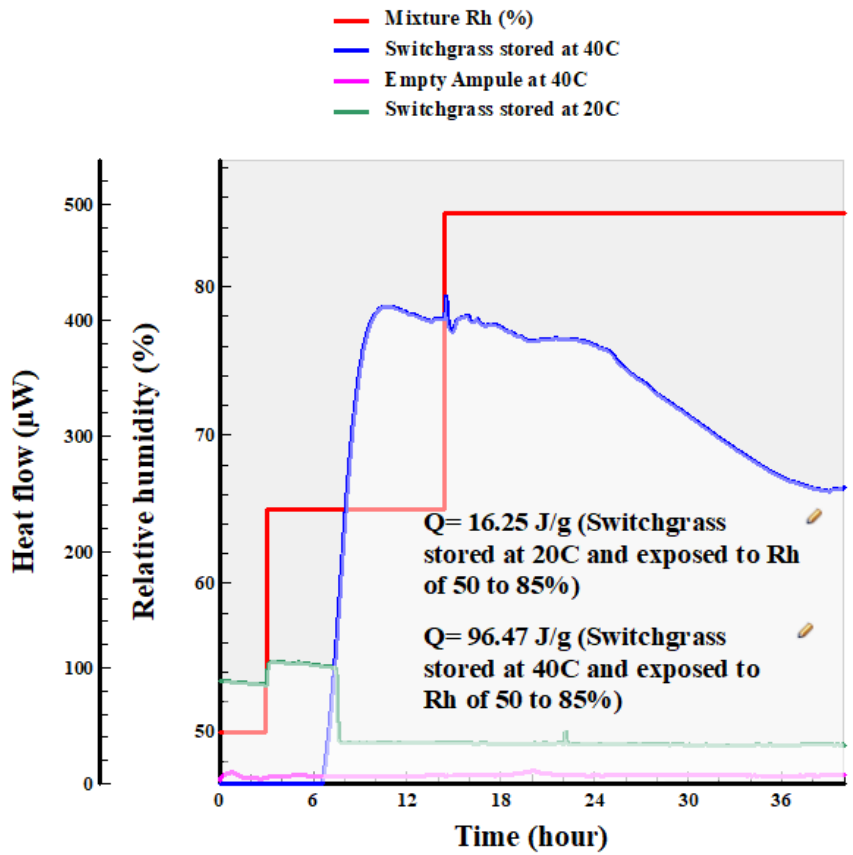


Figure 1 - Schematic drawing of an isothermal calorimeter

Reactivity: Oxidation, humidity and water uptake & biological





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Off-gassing and Oxygen Depletion

- Testing ag pellets for off-gassing and oxygen depletion characteristics
- The emission and depletion rate for various gas species emitted from sample within a closed test container is determined by means of gas chromatography.
- ISO 20048-2- Determination of off-gassing and oxygen depletion characteristics — Part 1: Laboratory method for the determination of off-gassing and oxygen depletion using closed containers was developed at UBC.

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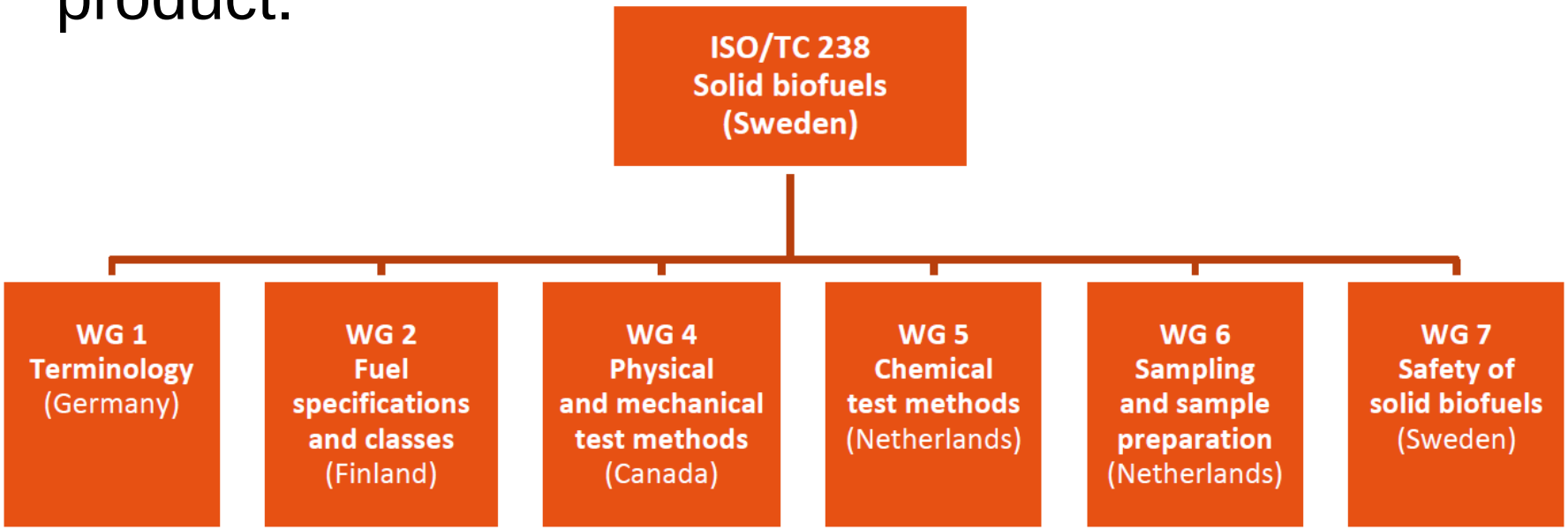
What do we mean by quality compliance?

To assure **safety of fuel**, to ensure that biomass feedstock and produced fuel are **tailored-made for their purpose**, facilitate **trade**, promote common understanding of the product.



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What is next?

- Develop ***pretreatment methods*** for agricultural biomass to ensure compliance of material with developed standards
- Develop ***best practices*** to minimize the degradation of biomass pellets during storage, handling, and transport
- Test reactivity of ag pellets under freezing and thawing condition

Knowledge Translation

Link to the above video:
https://vimeo.com/user82810432/review/424918356/d533c9e7e0

Thank you!

Q&A

Acknowledgement

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