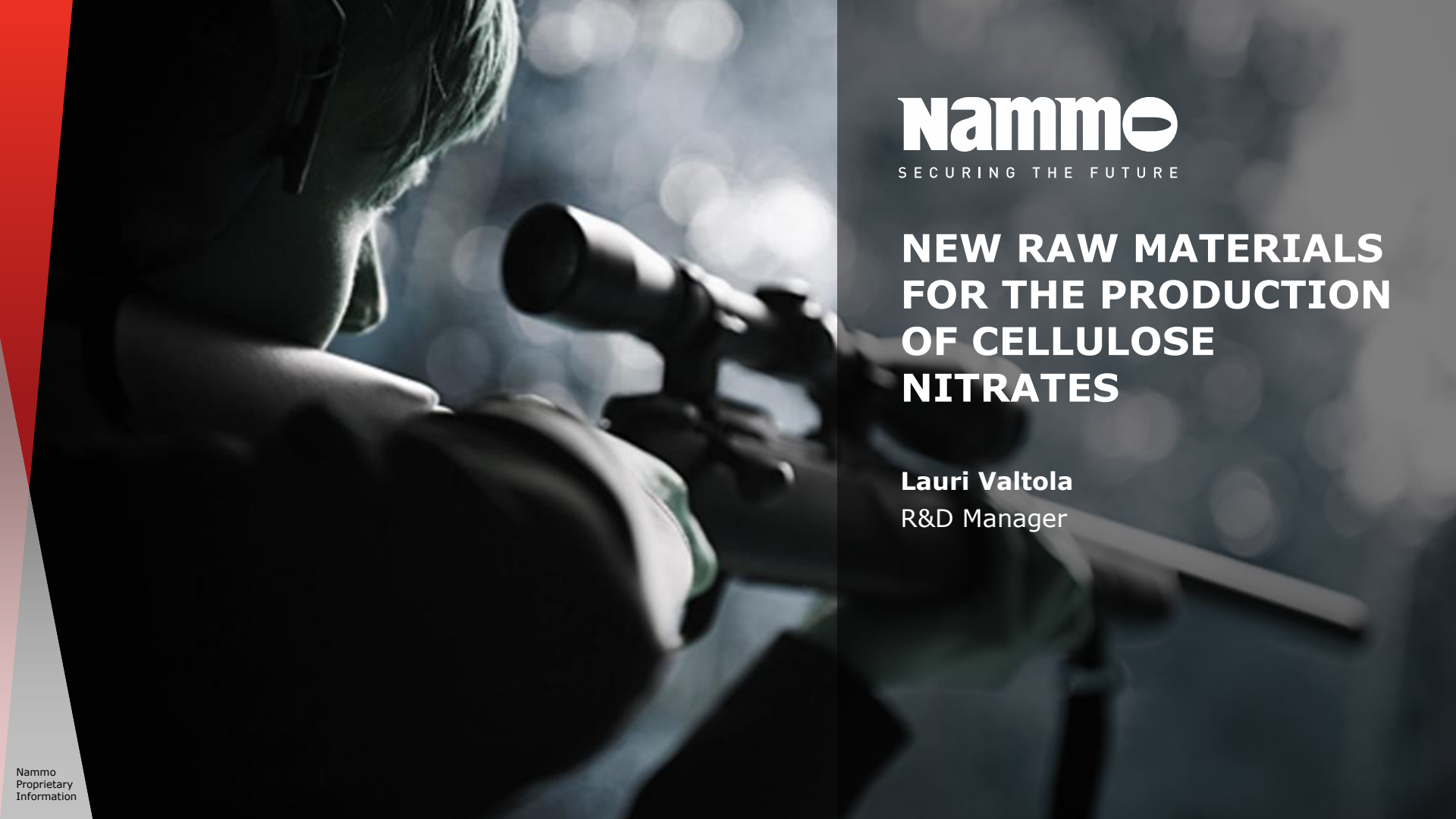


A black and white photograph of a person in a lab coat looking through a microscope. The person's face is in profile, and the microscope is in the foreground. The background is blurred with bokeh light effects. A red vertical bar is on the left side of the image.

Nammo

SECURING THE FUTURE

NEW RAW MATERIALS FOR THE PRODUCTION OF CELLULOSE NITRATES

Lauri Valtola
R&D Manager

NAMMO **WHO WE ARE**

International
company

Nordic
ownership

Norwegian
headquarters

WIDE FOOTPRINT

We have expanded significantly beyond our original Nordic base.



	1998	2018
People	1 100	2 300
Countries	4	14
Locations	8	35*)

*) Incl. 7 offices

6 BUSINESS UNITS

Business Unit

=

Area of Expertise



Small and Medium Caliber



Large Caliber



Shoulder-fired Systems



Aerospace Propulsion



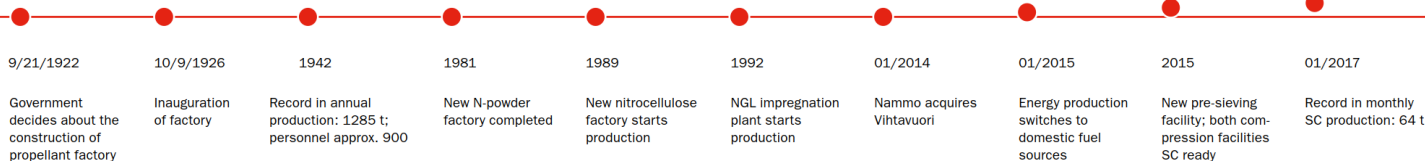
Commercial Ammunition



Demil, Sea Safety, Services

NAMMO VIHTAVUORI OY

- Factory founded 1922
- Production started 1926
- Main products:
 - Single base propellants
 - Nitrocellulose
 - Ether + other minor products
- 100 employees
- Other companies in the Site area:
Nammo Lapua Oy and Forcit
- Fenced factory area 235 ha including totally 323 buildings (161 NVri)



VIHTAVUORI

PRODUCTS



Single base + EI propellant



Semi products:

- Nitrocellulose
- Nitroglycerin
- Ether



Artillery, Mortal



Medium caliber



Reloading

<



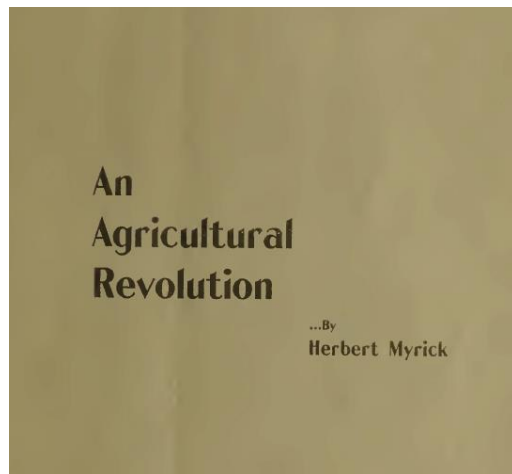
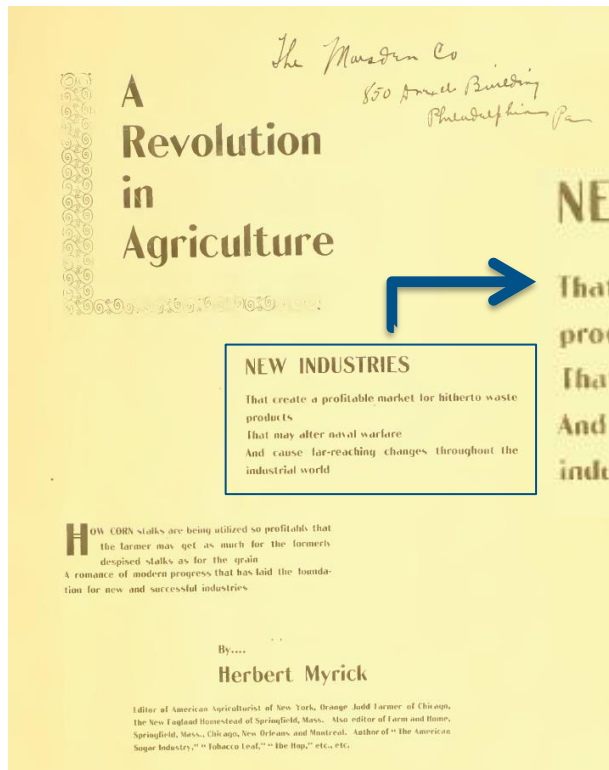
Target shooting, Hunting

NITROCELLULOSE FACTORY

- Capacity 2000 tn/a
- 1000 tn/a
- Own use 500 tn/a
- Raw materials:
 - Cotton (bale or roll)
 - Wood based cellulose (roll)



NEW RAW MATERIALS FOR THE PRODUCTION OF CELLULOSE NITRATES



NEW INDUSTRIES

That create a profitable market for hitherto waste products
That may alter naval warfare
And cause far-reaching changes throughout the industrial world

NEW RAW MATERIALS

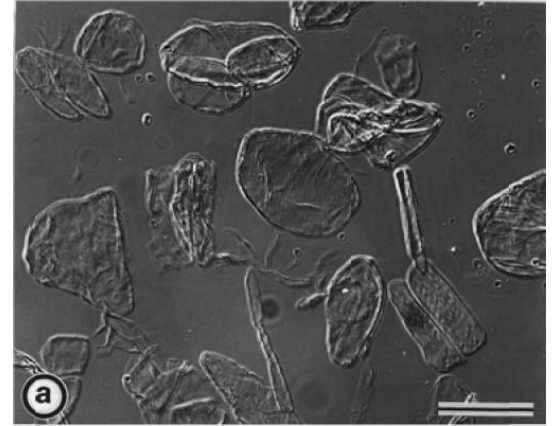
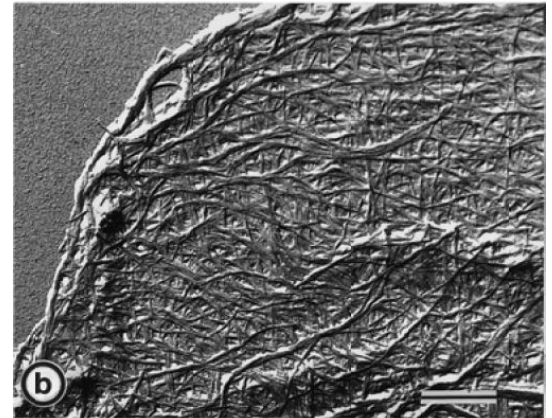
- Driving force €
 - The scope of this project was to bring new and never discussed ideas to the table regarding the development and production of high-end gunpowder products
 - A shift from wood and cotton based raw materials to food industry waste streams will drastically lower the cost of the cellulose products

COTTON AND WOOD BASED CELLULOSES

- Cell walls of all plant species consist partially of cellulose fibers
 - Wood and cotton; Fibers are extremely tightly bound to each other-> Form the main strengthening scaffold
 - >Mechanically durable
 - Individual elementary fibrils are difficult to extract

PARENCHYMAL CELL CELLULOSE

- Vegetable plant species the function of cellulose is different. Fibrils are loosely organized.
- Small lateral size of the elementary fibrils (2-4nm) and loose organization-> Chemical derivatization easier.



(a) Optical micrograph of disencrusted parenchyma cell-ghosts, scale bar 100 μ m. (b) TEM micrograph of the border of a disencrusted cell-ghost of parenchyma from sugar beet pulp, scale bar 500nm. **Dinand et al. *Food hydrocolloids* 13 (1999) 275-283.**

VEGETABLE BASED RAW MATERIALS

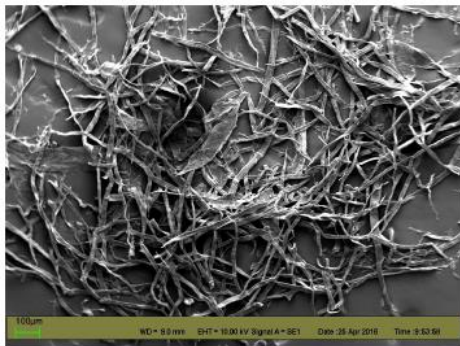
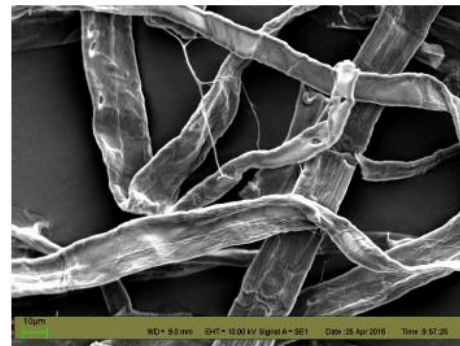
- Potato:
 - 15-30% Cellulose
 - 12-30% Pectins
 - 12-30% Hemicelluloses
- Sugar beet
 - 15-30% Cellulose
 - 12-30% Pectins
 - 12-30% Hemicelluloses
 - 2-6% Proteins
 - 2-6% Unsoluble minerals
 - 2-6% Lignin, Tannins, Polyphenols etc.

Purification

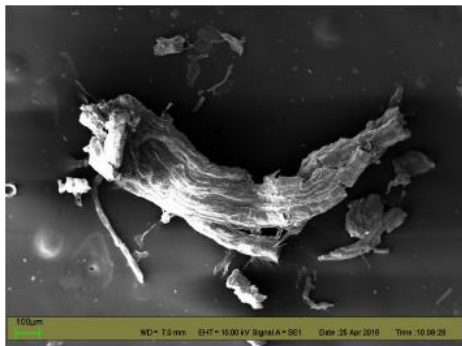
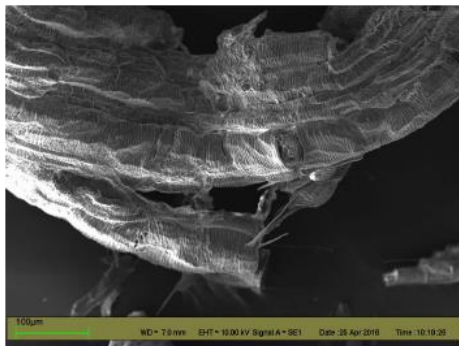
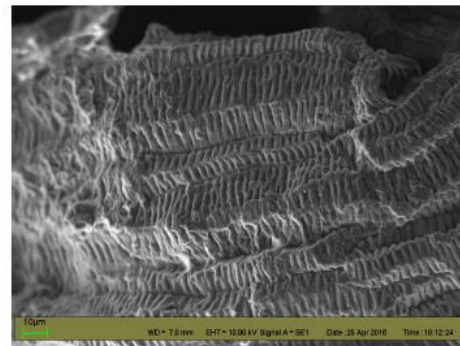


- Potato:
 - 93.6% Cellulose
 - 0.9% Ash
 - 97.4% Total amount of sugars
- Sugar beet
 - 73.4% Cellulose
 - 1.7% Ash
 - 80.4% Total amount of sugars

SEM



SEM Images of soft wood fibres



SEM images of vegetable based fibres

NITRATION PROCEDURE

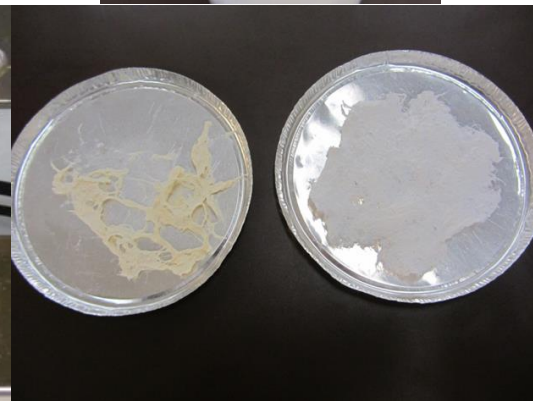


- Reaction time 60 min
- Temperature 25 °C
- Stirring 250 rpm
- Cellulose acid ratio 1:23

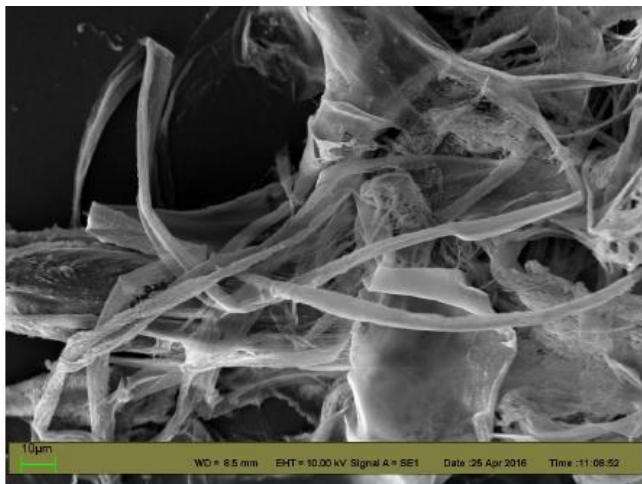


PURIFICATION

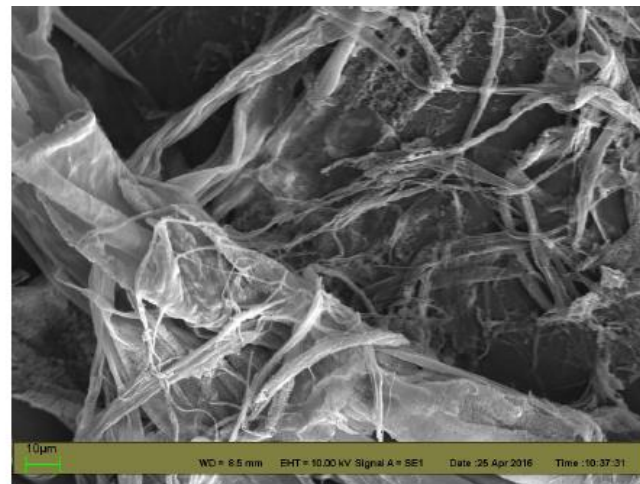
- Dissolution to acetone
- Precipitation in water
- Drying
- Analyzation of N%



SEM



SEM Image of nitrated hard wood fibres



SEM image of nitrated vegetable based fibres

NITRATION RESULTS

Target 13.3%

- Hardwood 13.4%
- Potato 12.8%
- Sugar beet 11.7%

Target 12.4-12.7%

- Hardwood 12.3%
- Potato 12.1%
- Sugar beet 11.9%



CONCLUSIONS

Herbert Myrick was right!

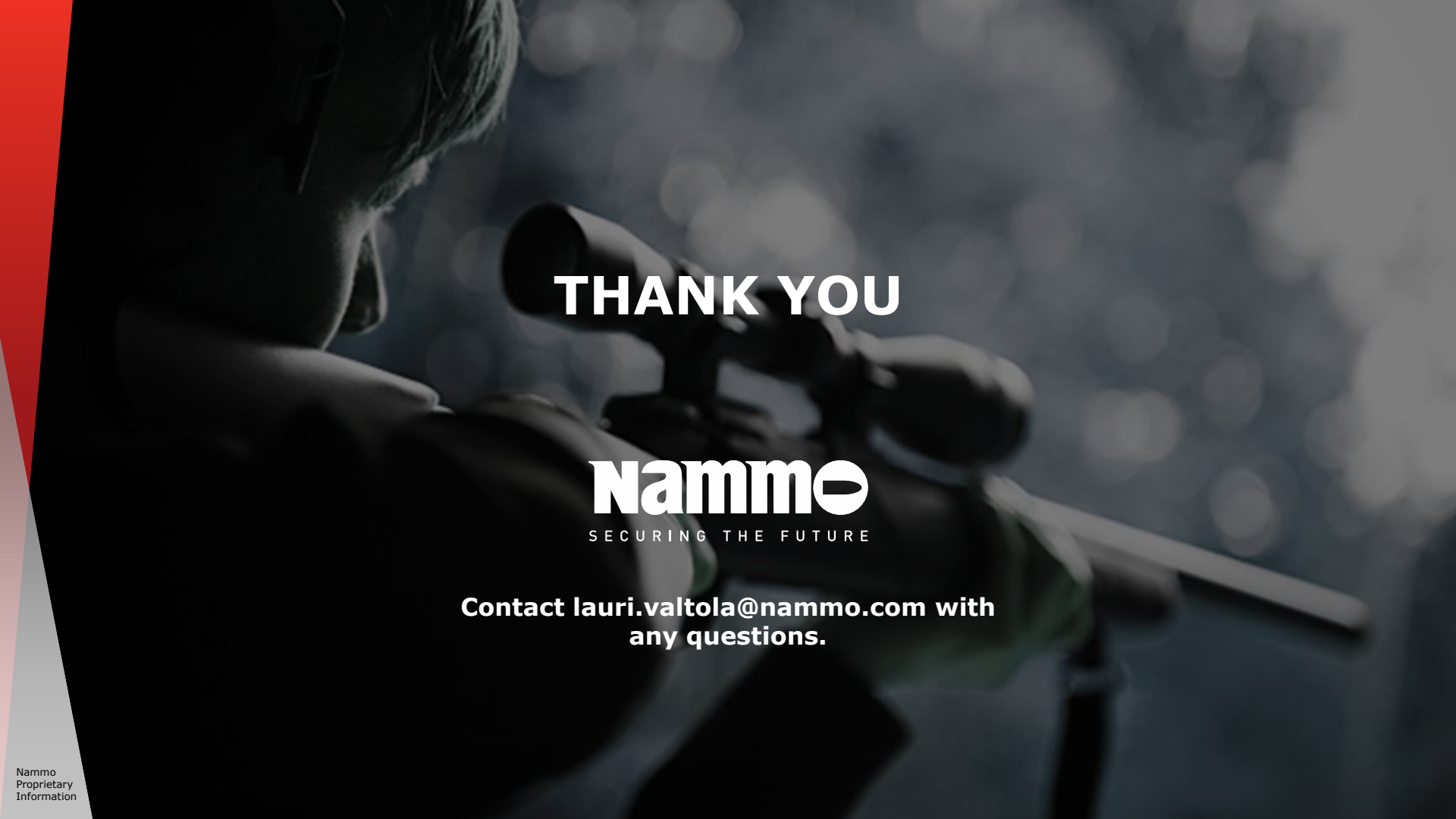
- There is always needs to find new alternative raw materials for manufacturing cellulose nitrates
- Nitration of wood and vegetable based cellulose was discussed
- Concerns arise mainly, from the non-cellulosic components and purity of the raw material

ACKNOWLEDGEMENTS

BUSINESS FINLAND

University of Jyväskylä
Sonja Vuori

Betulium Oy

A black and white photograph of a person's profile, looking through binoculars. The background is a soft, out-of-focus bokeh of light and dark spots. A solid red vertical bar is on the left side of the image.

THANK YOU

Nammo
SECURING THE FUTURE

**Contact lauri.valtola@nammo.com with
any questions.**