DEVELOPING ADVANCED BIO-BASED COMPOSITES

www.ssuchy.eu
ssuchy_eu
ssuchy

INNOVATIVE HEMP VALUE CHAIN FOR COMPOSITE REINFOCEMENTS

SCIENTIFIC OUTCOMES: FROM THE FIELD TO THE FABRICS

Pierre Ouagne (Ecole Nationale d'Ingénieurs de Tarbes)

Contributions from UCSC (Salvatore Musio, Stefano Amaducci), ENSAIT (Anne Clémence Corbin, Chamae Laqraa, Ahmad-Rasheed Labanieh, Manuela Ferreira, Damien Soulat) and KUL (Gilles Koolen, Aart Van Vuure), UFC (Xavier Gabrion, Vincent Placet) and LCN (Debora Botturi, Fabio Traina, Pier Luigi Fusco Girard, Giorgio Rondi) ENIT (Marie Grégoire, Mahadev Bar, Emmanuel de Luycker, Pierre Ouagne)

BBI JU
Bio-based Industries Consortium
Horizon 2020 European Union Funding for Research & Innovation

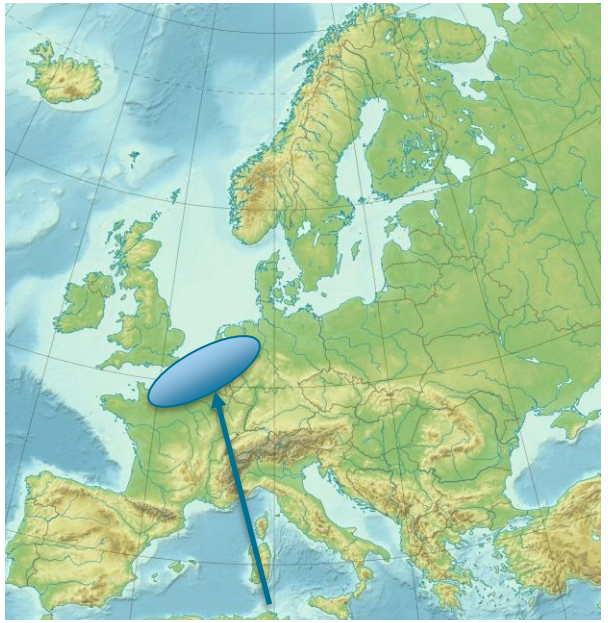
Final Event *– Videoconference – 9th February 2022*

DIFFERENT TERRITORIES/DIFFERENT PRODUCTION ROUTES

Textile flax production zone

Scutching/hackling route

Requires 1 m long dew retted stems



Traditional dew-retting zone in Europe

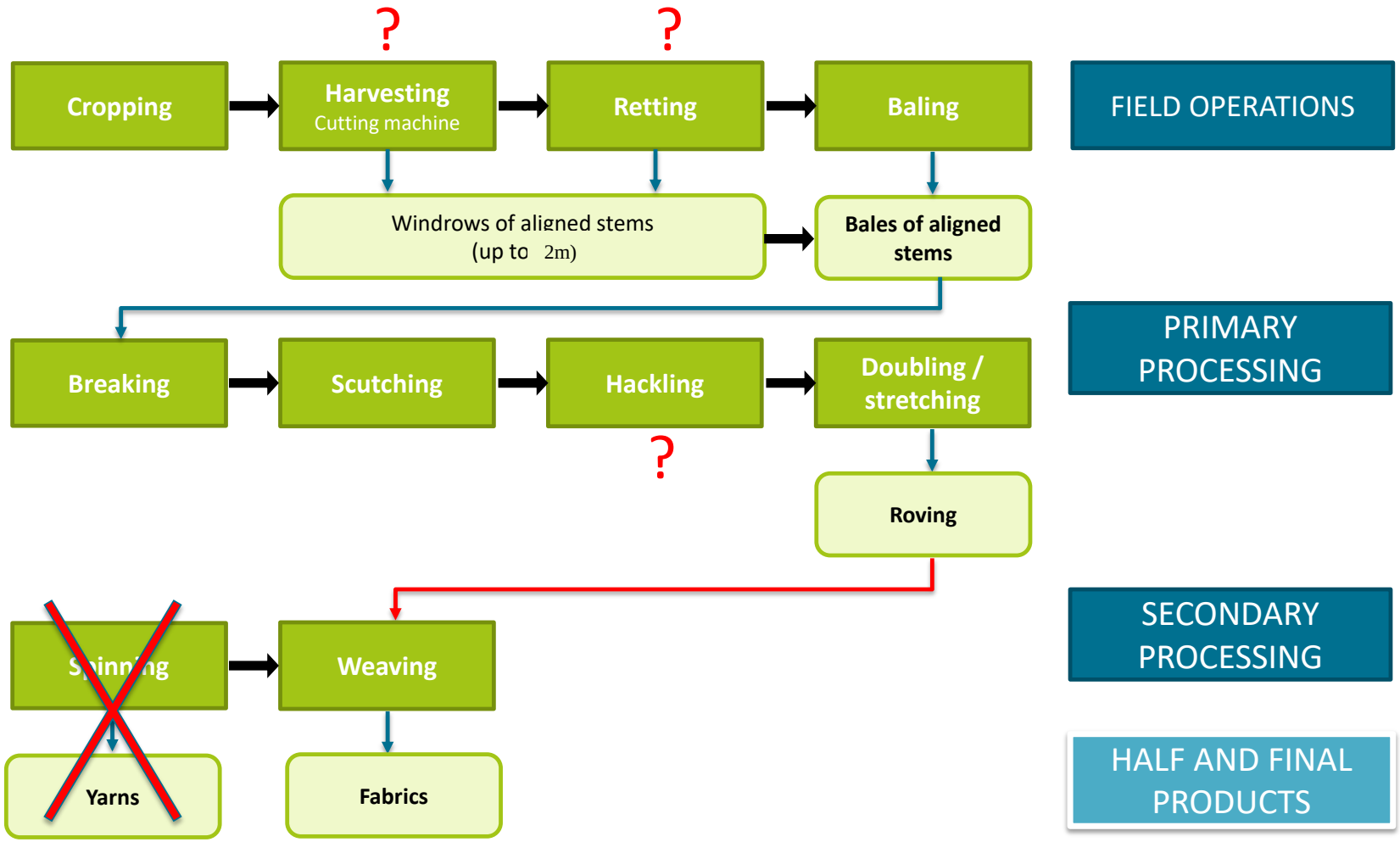
Other production zones

Breaking/carding route

Randomly aligned dew-retted stems

IN TEXTILE FLAX TERRITORIES: USE OF THE FLAX VALUE CHAIN

Adaptation and simplification of the “textile production method“



INNOVATIVE HARVESTING OF HEMP STEMS

Industrial mowing using a front reaper

Goal is to obtain aligned stems of 1 m length adapted to flax returning, bailing and scutching machineries

Returning machine

Cutting of hemp stems in 1 m pieces

TWO HARVESTING PROTOTYPES DEVELOPPED IN NORMANDY

Separate top and botton parts, and lay them down parallel on the ground

15 ha harvested in 2021, with more than 80 ha in 2022
and exponential growth for 2023 and 2024

STEM AND FIBRE YIELDS

Variety	Harvested area (m^2)	1st meter (ton)	2nd meter (ton)
Futura 75	5000	2.6	1.3
Fibror 79	2400	1.7	1

Stem yields of 7.9 and 11.2 tons/ha for futura 75 and Fibror 79

800 kg and 7.6 tons of dew retted stems produced in 2018 and 2019 by UCSC Piacenza Italy

Fibre yields after scutching:

- **27% at laboratory scale for Futura 75 (18% after hackling)**
- 30% Futura 75 with 12% long line fibres and 18% tows
- 37.5% Fibror 79 with 14% long line fibres and 23.5% tows

500 kg of hackled fibres available for further transformation

FIBRE PREPARATION AND YARN MANUFACTURING

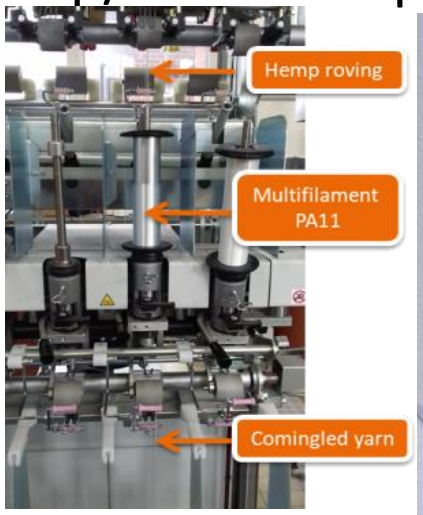
(a) Sliver input into the gill system

(b) Drawn sliver at the output of the second stage

Drawing/doubling

Roving machine

Hemp/PA Co-wrapped yarns



Co-wraping technology

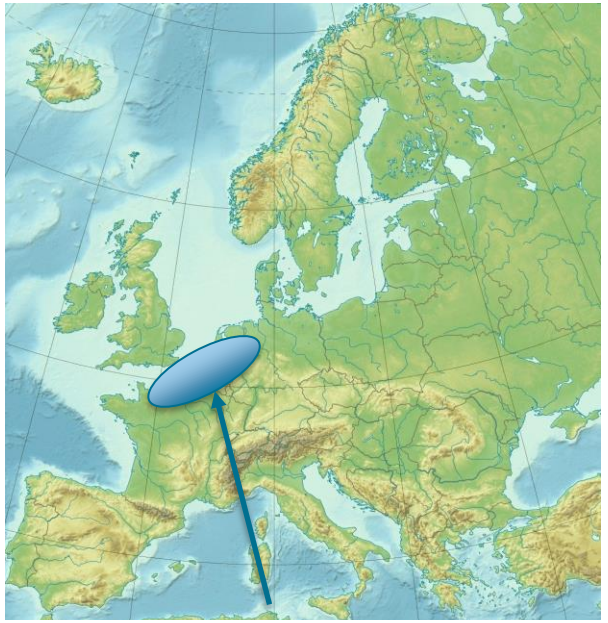
Roving type yarns 350 kg

DIFFERENT TERRITORIES/DIFFERENT PRODUCTION ROUTES

Textile flax production zone

Scutching/hackling route

Requires 1 m long dew retted stems



Traditional dew-retting zone in Europe

Other production zones

All-fibre route

Randomly aligned dew-retted stems

BREAKING ROLLERS AND BREAKING CARD ROUTE IN NON-FLAX TERRITORIES

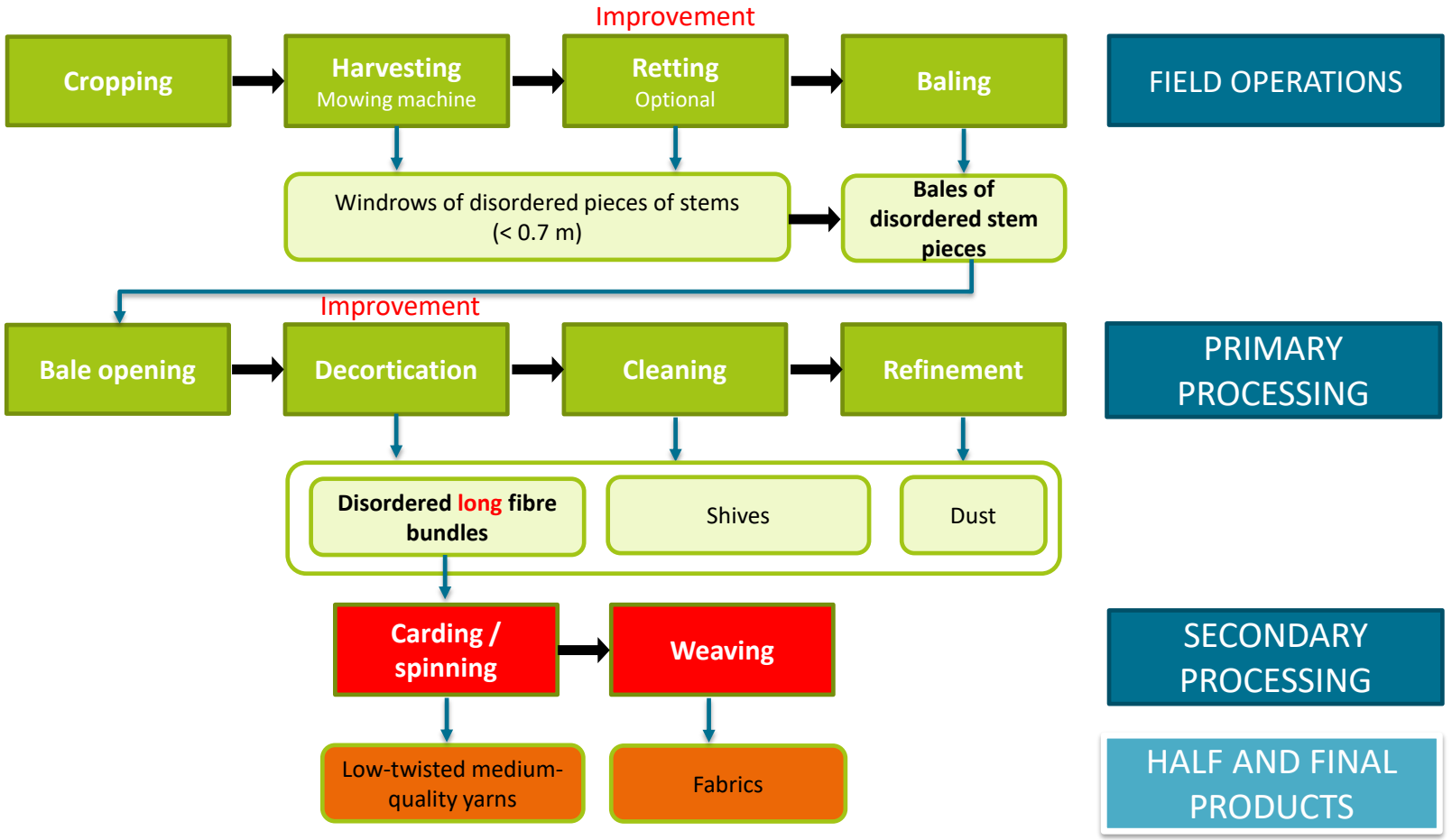
USE OF TRADITIONAL FIELD MANAGEMENT DEVICES

With seed harvesting

Without seed harvesting

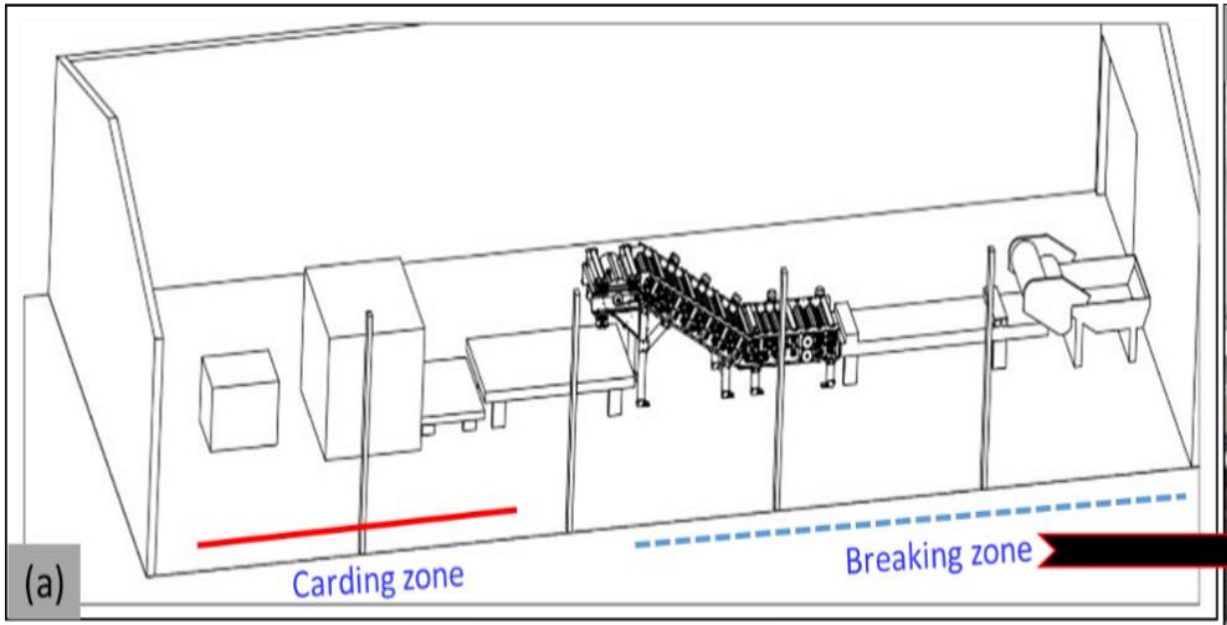
OUT OF FLAX TERRITORIES: USE OF CARDING ROUTE

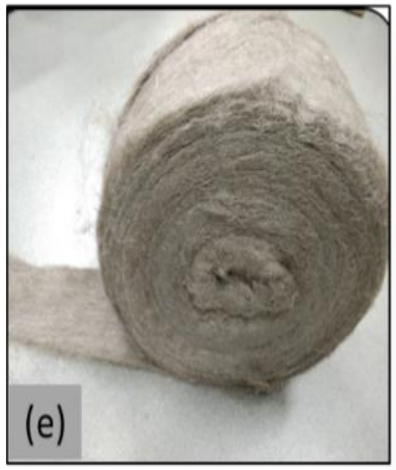
STRATEGY 2: Adaptation and improvement of the “short-fibre method“



BREAKING ROLLERS/BREAKING CARD ROUTE

(Hemp-Act company)





FIBRE REINFORCEMENT POTENTIAL

Fibre properties: Scutched/hackled

Batch	Strength (MPa)	E modulus (GPa)
Roving elementary fibres	857 ± 367	43 ± 19
Roving IFBT	**430±53**	**55±7**

Fibre properties: Carded

Batch	Strength (MPa)	E modulus (GPa)
Roving elementary fibres	621±217	31±15
Roving IFBT	**641±73**	**48±3**

- Stiffness is higher with scutched/hackled fibres
- Strength higher with carded fibres
- Properties of fibres extracted from both routes are suitable for composite reinforcement

INDUSTRIAL CHAIN

WEAVABILITY AT LAB AND INDUSTRIAL SCALES

Weaving at lab scale

Weaving at industrial scale

- Scutched/hackled rovings are weaveable at the laboratory and industrial scale using classical loom
- Carded rovings can be be woven in weft at the industrial scale

REINFORCEMENT MANUFACTURING

Braiding of hemp roving

Hemp Quasi-UD (95-5%)

Woven fabrics from comingled yarns

- More than 20 patterns of woven and Quasi-UD were manufactured and transformed in composites from 100% hemp or co-wrapped rovings
- Braids were manufacured from 100% and co-wrapped rovings

REFERENCES

- Gregoire, M., De Luycker, E., Bar, M. Musio S, Amaducci S, Ouagne P. Study of solutions to optimize the extraction of hemp fibers for composite materials. SN Appl. Sci. 1, 1293 (2019)
- Grégoire M, Barthod-Malat B, L. Labonne L, P. Evon P, De Luycker E, Ouagne P. Investigation of the potential of hemp fibre straws harvested using a combine machine for the production of technical load-bearing textiles. Industrial Crops and Products, 2019, 111988, https://doi.org/10.1016/j.indcrop.2019.111988.
- Grégoire M, Bar M, De Luycker E, Musio S, Amaducci S, Gabrion X, Placet V, Ouagne P. Comparing flax and hemp fibres yield and mechanical properties after scutching/hackling processing, Industrial Crops and Products, 2021, 114045, https://doi.org/10.1016/j.indcrop.2021.114045.
- Réquilé S, Mazian M, Grégoire M, Musio S, Gautreau M, Nuez L, Day A, Thiébeau P, Philippe F, Chabbert B, Chamussy A, Shah DU, Beaugrand J, Placet V, Benezet JC, Le Duigou A, Bar M, Malhautier L, De Luycker E, Amaducci S, Baley C, Bergeret A, Bourmaud A, Ouagne P. Exploring the dew retting feasibility of hemp in very contrasting European environments: Influence on the tensile mechanical properties of fibres and composites, Industrial Crops and Products, 2021, 113337, https://doi.org/10.1016/j.indcrop.2021.113337.
- A.C. Corbin, D. Soulat, M. Ferreira, A. R. Labanieh. Influence of process parameters on properties of hemp woven reinforcements for composite applications: mechanical properties, bias-extension tests and fabric forming. Journal of Natural fibers, published on line 12 May 2020. https://doi.org/10.1080/15440478.2020.1761925
- A.C. Corbin, M. Ferreira, A. R. Labanieh, D. Soulat, Natural fiber composite manufacture using wrapped hemp roving with PA12. Materials Today: Proceedings, 2020, 31, S329–S334 https://doi.org/10.1016/j.matpr.2020.02.307
- C. Laqraa, M. Ferreira, A-R Labanieh, D. Soulat - « Elaboration by wrapping process and multiscale characterisation of thermoplastic bio-composite based on Hemp/PA11 constituents » Coatings 2021, 11, 770. https://doi.org/10.3390/coatings11070770
- A.C. Corbin, D. Soulat, M. Ferreira, A. R. Labanieh, X. Gabrion, P. Malecot, V. Placet Towards hemp fabrics for high-performance composites: Influence of weave pattern and features. Composites Part B: Engineering, 2020, vol.181:107582. https://doi.org/10.1016/j.compositesb.2019.107582
- A.C. Corbin, B. Sala, D. Soulat, M. Ferreira, A. R. Labanieh, V. Placet. Development of quasi-unidirectional fabrics with hemp fiber: A competitive reinforcement for composite materials. Journal of Composite Materials, 2021, vol.55 (4): pp:551-564. https://doi.org/10.1177/0021998320954230

www.ssuchy.eu
ssuchy_eu
ssuchy

Horizon 2020
European Union Funding
for Research & Innovation

This project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation program under grant agreement No 744349.