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“To explore the potential of nature to improve the quality of life"

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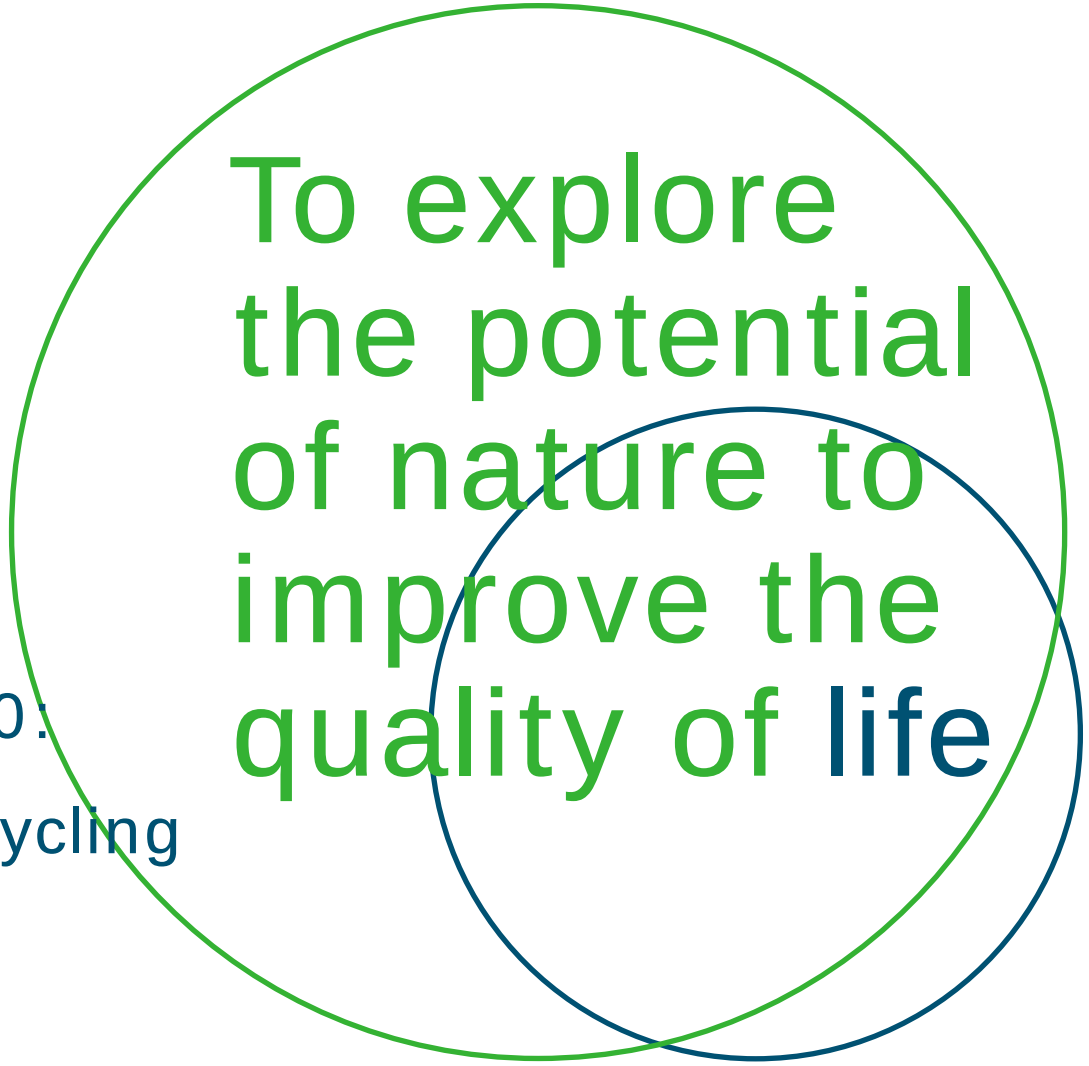
The WUR Textile Programme

- Cotton in its context (studies on the future of cotton in relation to climate change)
- Agrofood residues to textiles (started in Asia, to be expanded in Europe)
- From Biopolymers to plastics (and textiles)
- Design and organizing textiles for recycling (participation in two EU Horizon projects)

Wageningen mission



The road to fully biobased textiles in 2050: from better fibers to recycling – industrial challenges

Dr. Michiel Scheffer, Davos 17-19 Sept 2022

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Textiles need to be fossil-free by 2050

Use of fossil-free (renewable) materials is an essential ingredient to become CO2 neutral in 2050

Depletion of fossil resources between 2040 and 2050

Other factors: depletion of antimony, problem of micro plastics

Recycling is not a perpetuum mobile (new virgin fibre is needed)

The challenge is around: 70 Mln Tons but growing to 100 Mln Tons in 2050. That is a transition of 3 Mln/Tons a year.

Food vs Fuel: Textile is less than 1% of fossil fuel use, but also less than 2% agro-food production. Challenge is clever dual use.

Main roads to CO2 Neutrality

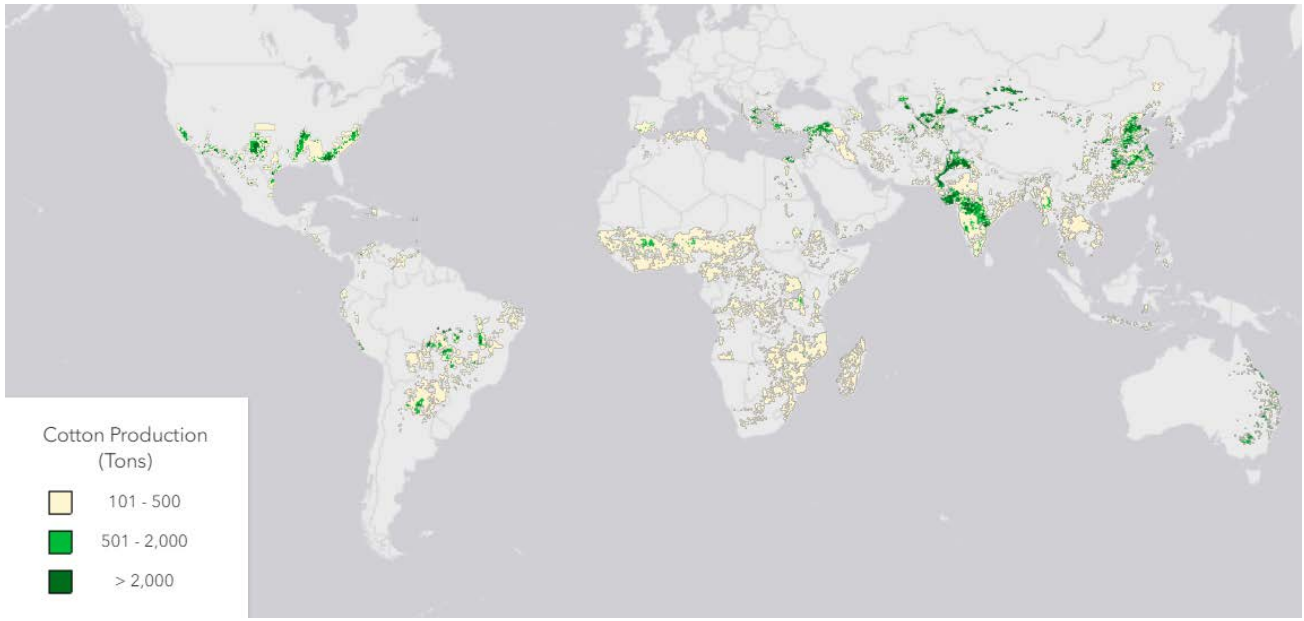
- Less consumption in kg (unlikely)
- More recycling (from less than 5% now to 30%)
- More natural fibres
  - Better Cotton
  - Hemp and other neo-traditionals
- Alternative sources for cellulosic and synthetic fibres

What do they have in common

- Need to assess fibre impact in their eco-systems
- Recreate connections between agriculture and fashion
- All need design for recycling (from genetic redesign of plants, to redesign of products)
- Align investments to scale up from agriculture to spinning
- Better governance of value chains (now too scattered, underfunded and powerless)

Cotton in context

Global cotton production



https://ipad.fas.usda.gov/cropexplorer/cropview/commodityView.aspx?cropid=2631000

- Cotton production is scattered across the globe but under pressure from higher yield crops
- It faces many sustainability challenges such as human rights violations, chemical use and climate change
- Towards the future, integrated sustainability is critical for accepted, resilient and high quality cotton

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Towards Better Cotton

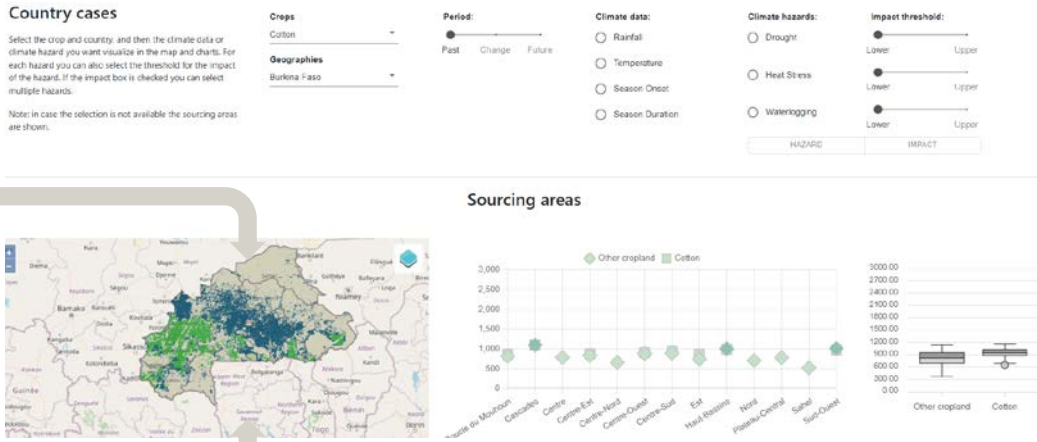
- Sustainability needs higher income for farmers through higher yields and higher grades
- Need for regenerative agricultural concepts and better water (input) management
- For better recyclability: more longer fibre volumes and higher DPI
- Fragmented governance of the value chain

WUR & Cotton research (II)

Climate change
Pressure from cattle farming

Climate change
Pressure from plantations
(cocoa, palm oil,...)

PPP Climate resilient agri sourcing in Africa
(incl. 8 cotton producing countries)



https://www.wur.nl/en/project/climate-resilient-agri-sourcing-in-africa.htm

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Other natural fibres

- Revival of wool: good potential – especially on marginal lands (mountains, moors and fens), but remains a niche product
- Flax is an evergreen: interesting fibre but growth limited because of rotational crop systems
- Hemp is a perenial promise: great crop, tough fibre. Lack of growth because of lack of alignment in the value chain

- All need better policies, value chain governance and alignment of investments

Agro-Food residues for textile use: Beyond The Laudes Study

https://www.laudesfoundation.org/learning/research/2021-07-01-spinning-future-threads

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Wat are agrofood residues?

Primary: Post harvest residues (e.g. straw)

Secundary: Industrial waste (e.g. bagasse)

Tertiary: Retail waste (orange peel, coffee ground, unsold vegetables)

Quartery: Domestic waste

Real potential is primary and some secondary waste streams. Tertiary and quartery is to degraded, mixed and fragmented, compost and energy is better use.

Primary residues: what can be extracted

- Left after burning: (burning straw is more and more banned)
- Left after ploughing back into the soil
- Left after using for domestic or local building use

- harvestable as relatively pure/dry streams and transportable

What is the path to textiles

- Direct extraction of fibres (like cotton, flax, cocos)
- Pulping towards cellulose and MMCF
- Conversion into sugars and polymers to e.g. PLA
- Conversion into methane (or energy for textile production)

The three roads to fibres

Bast Fibres Scutching, Hackling	Ligno/Cellulosic Pulping	Sugars Pressing, Monomer
		
		
Cotton, Hemp, Flax, Cocos, Jute	MMCF: Viscose, Acetate, Rayon	Synthetics: Polyester, Polyamide, Acrylic, ...

What have we found in 8 countries

- Direct fibre material 50 Mill Ton (but low quality)
- Primary waste: mainly straw ca. 1 Bill Ton/year
- Secundary waste (e.g. husks): 260 Mill Tins
- Sugar and starches (e.g. bagasse): 120 Mill Tons
- Fruit and vegetables have limited potential

Geographical focus: 40% of world crop production in 8 countries

Main crops found

Rice	Cellulose
Palm	Cellulose and Sugars
Wheat	Cellulose
SugarCane	Sugars
Maize	Sugars and Cellulose
(Kapok)	(Direct fibre and Cellulose)

Main relevant crops per country

Key ratio's in Asia

- High enough concentration of cellulose (35%+) or sugars, Lignin level below 20%
- Absence of silicates and other inhibitors
- Incentive for the farmer (cash revenue)
- Efficient (short) processing pathways
- Geographical critical mass and transportation
- Availability 4/5 T-Ha (250/300 Euro income/ha)
- Primary fibre extraction 100/1000 T
- MMCF processing average 150000 KT

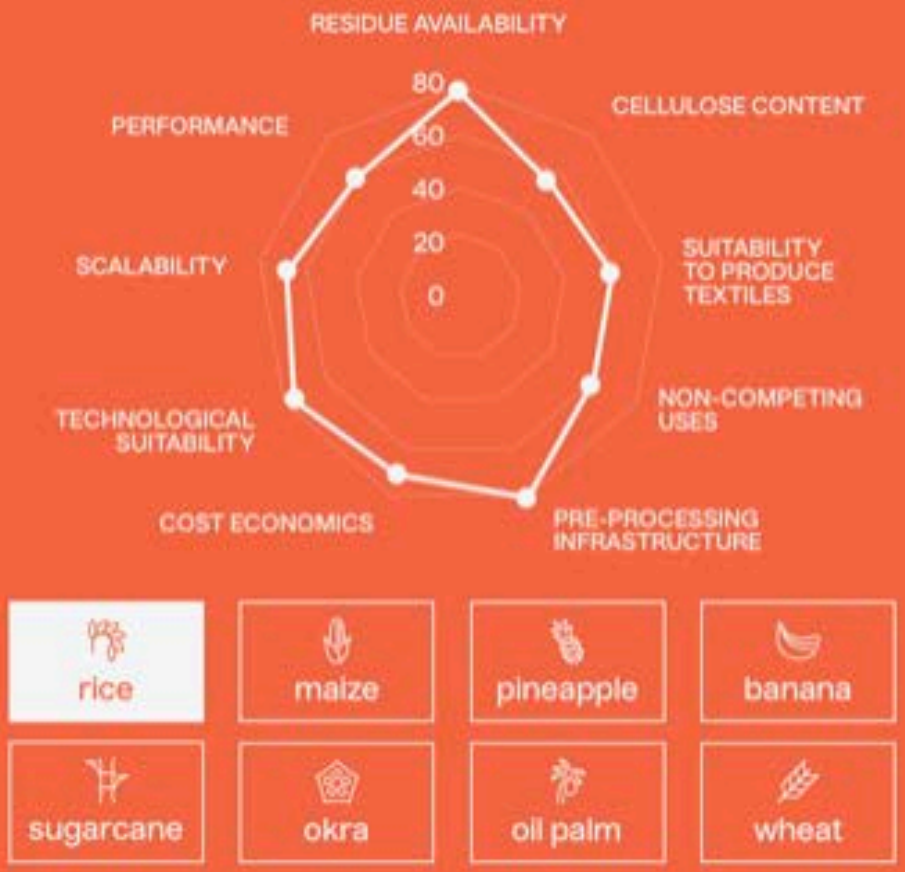
Suitability for Textiles

RICE (Wheat)

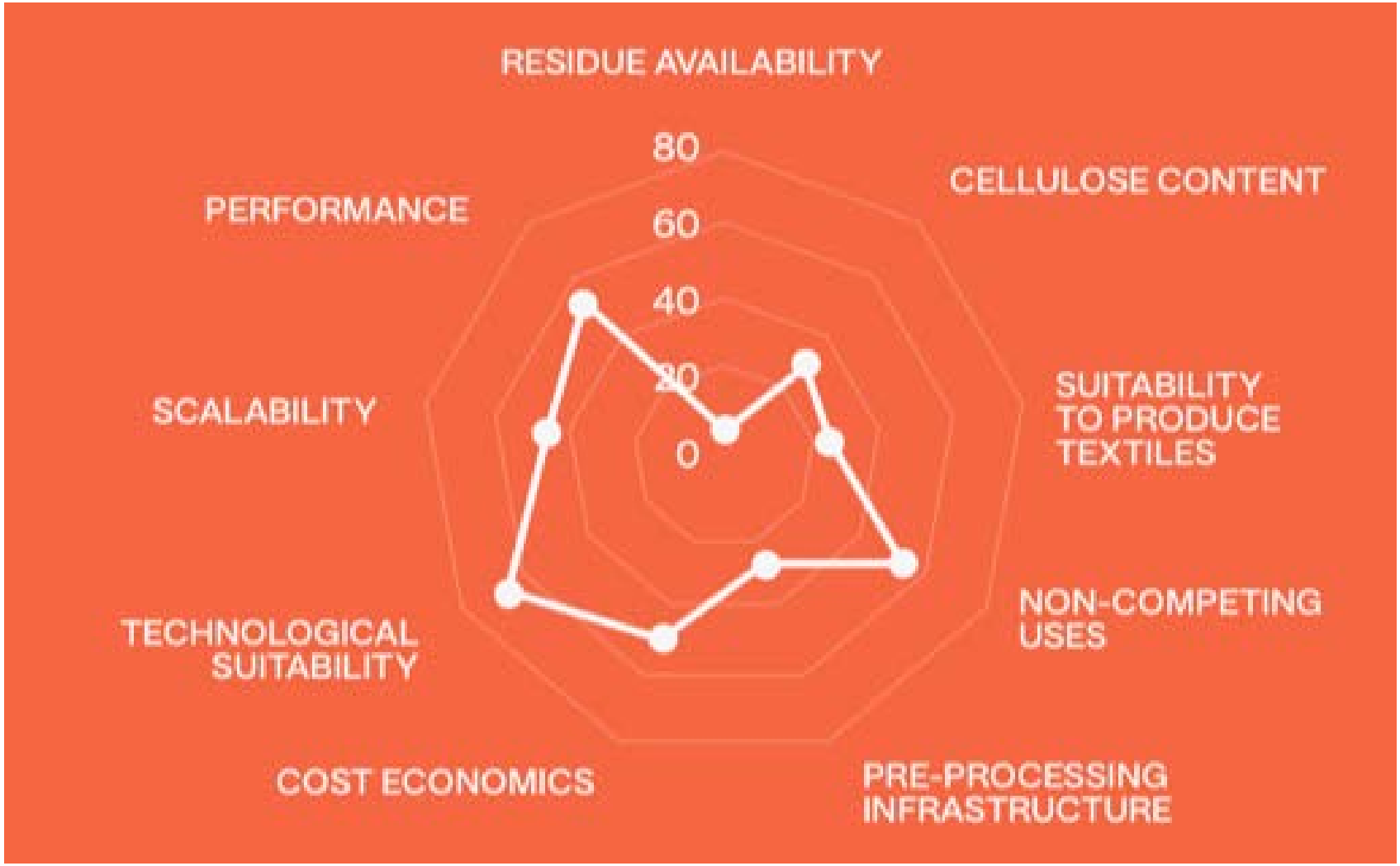
Residue streams with high potential

Overall, the findings indicate that rice straw offer the largest potential across all eight countries, followed by Empty Fruit Bunches (EFBs) from oil palm. Both sources also offer the best cost economics.

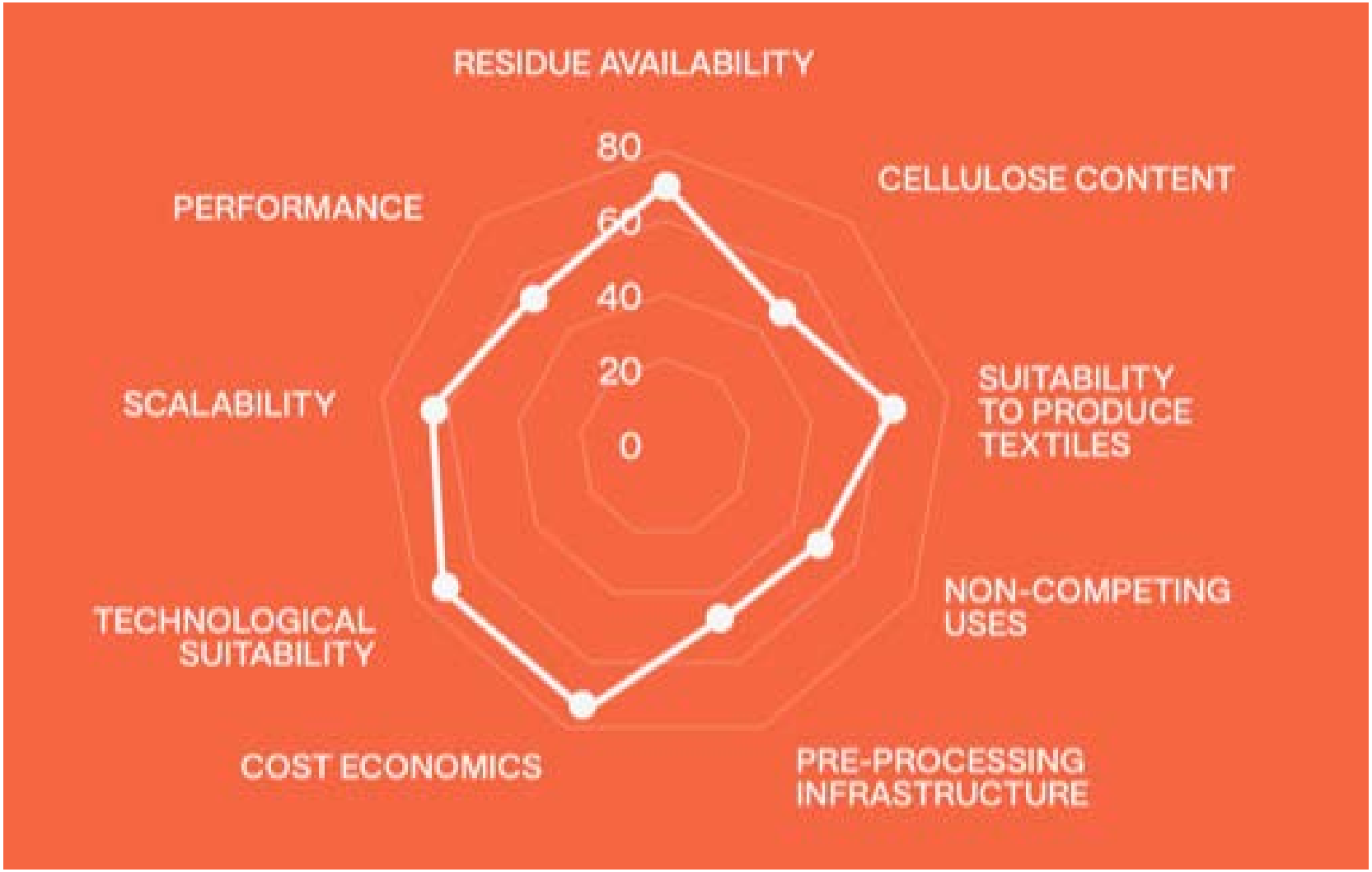
Wheat straw, sugar cane bagasse, banana pseudo-stem, maize and sorghum also offer potential. However, to extract cellulose from these residue streams first some technical challenges must be overcome.



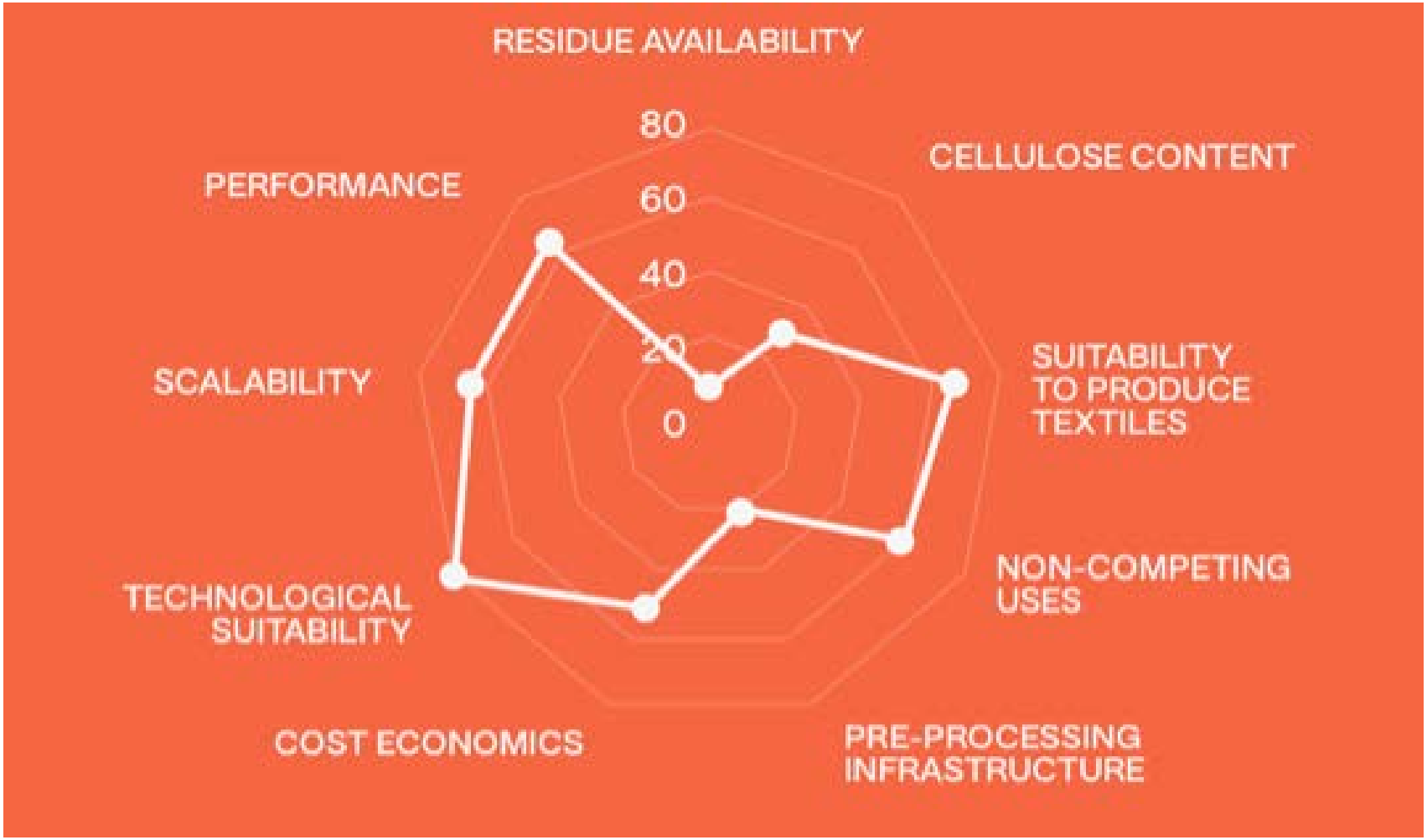
OKRA


RESIDUE AVAILABILITY
CELLULOSE CONTENT
SUITABILITY TO PRODUCE TEXTILES
NON-COMPETING USES
PRE-PROCESSING INFRASTRUCTURE
COST ECONOMICS
TECHNOLOGICAL SUITABILITY
SCALABILITY
PERFORMANCE
80
60
40
20
0

PALM RESIDUES



PINEAPPLE (Banana)



The challenge

- Biggest potential is cellulose to MMCF: challenge is to organize logistics and primary extraction in 1000T units _ expansion of mature MMCF fibre production for known and accepted consumer properties
- Very limited potential for direct fibre extraction: lack of capacities at each stage, poor functionality and relative high prices
- Good potential of sugar, but challenges at each level and not yet mature technologies, accepted functionality and price competitiveness

What next

- Understand the impact of policies on fibre prices
- Contribute to develop fibre hubs in SE Asia
- Expand vision on availability of agro-food residues in Europe (study ongoing); N.America, S.America
- Develop a road map for EU (looking at synergies in GreenRecoveryPlans) and align investments
- Organize value chains and an international governance across borders

Thank you

Laudes Study:
https://www.laudesfoundation.org/learning/research/2021-07-01-spinning-future-threads

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