UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

An overview of fibre crop cultivation and multi-product value chains for post-mining industrial development

CENTRE FOR BIOPROCESS ENGINEERING RESEARCH

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MINERALS TO METALS INITIATIVE

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Problem statement

Over 5900 abandoned mines in SA

Over 300, 000 job losses since 1987

Significant loss of biodiversity

Exploring the potential of fibrous plants

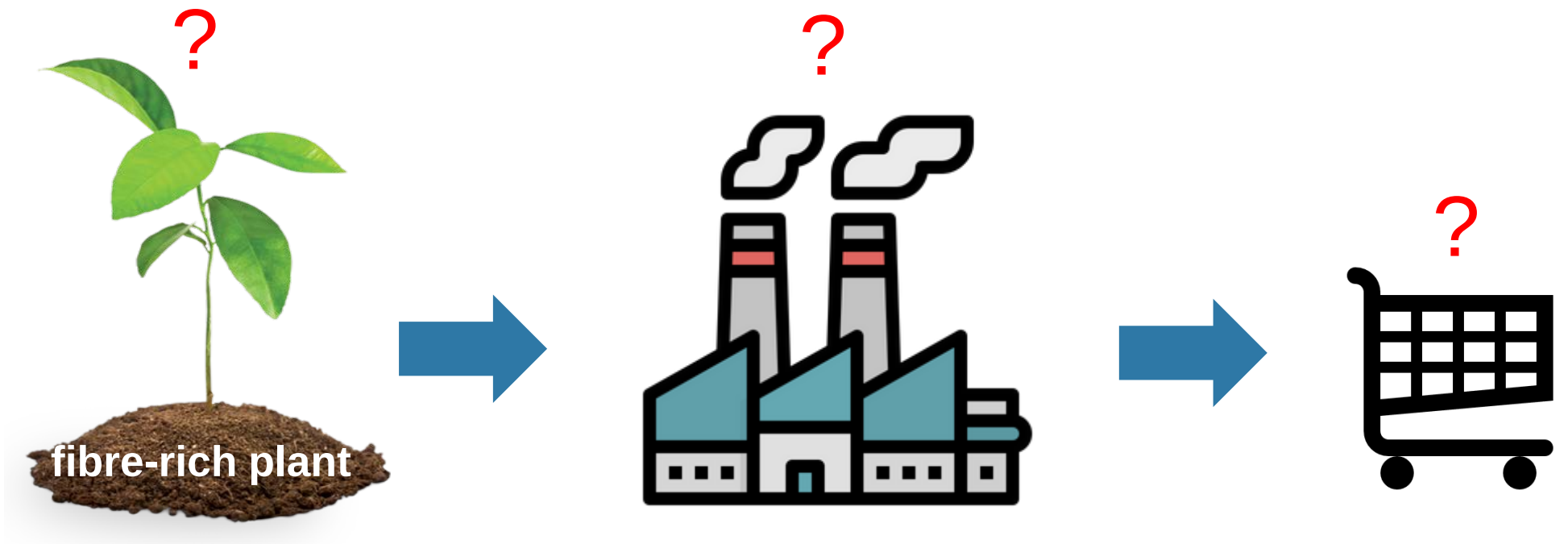
Fibre crop potential

Land remediation potential

Metal recovery potential

Fibre-derived products

Key questions?



Can fibre-rich plants serve the joint role of remediation of degraded mine land and fuelling of a multi-product value chain?

What are the downstream processing options for the recovery of value from fibre plants?

Proposed solution

Exploring the potential of fibrous plants

Land remediation and metal recovery

Phytoremediation & Phyto-mining

Metal ions

Proposed solution

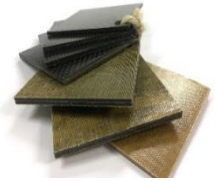
Exploring the potential of fibrous plants

Fibre-derived products

Fibre

Fibre

fabric



thermoplastics

Additional products

Woody tissue

cordage

bio-composites

piping

shives

Chemicals

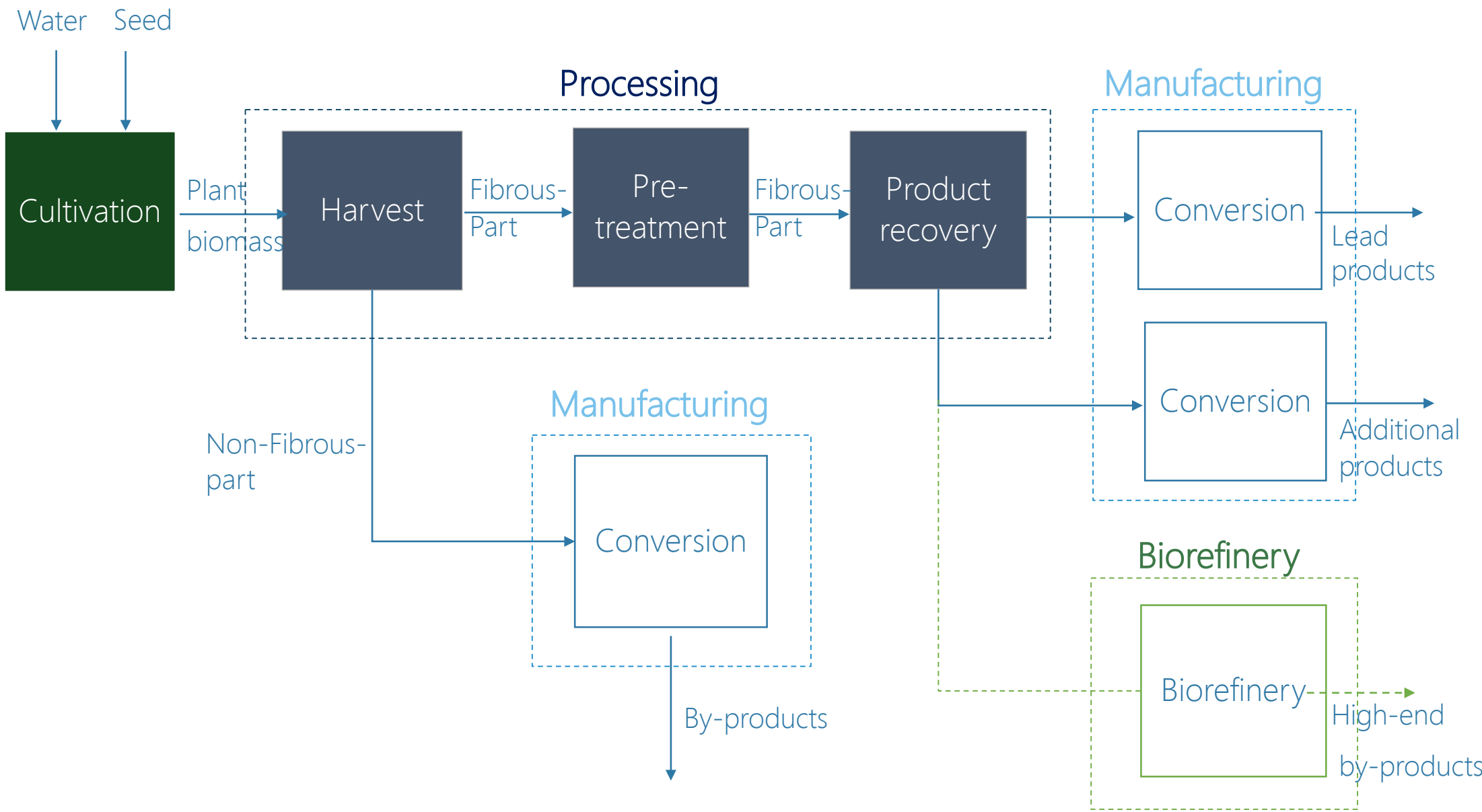
oils

pharmaceuticals

Energy

bio-char

Potential System Flowsheet



Example site selection

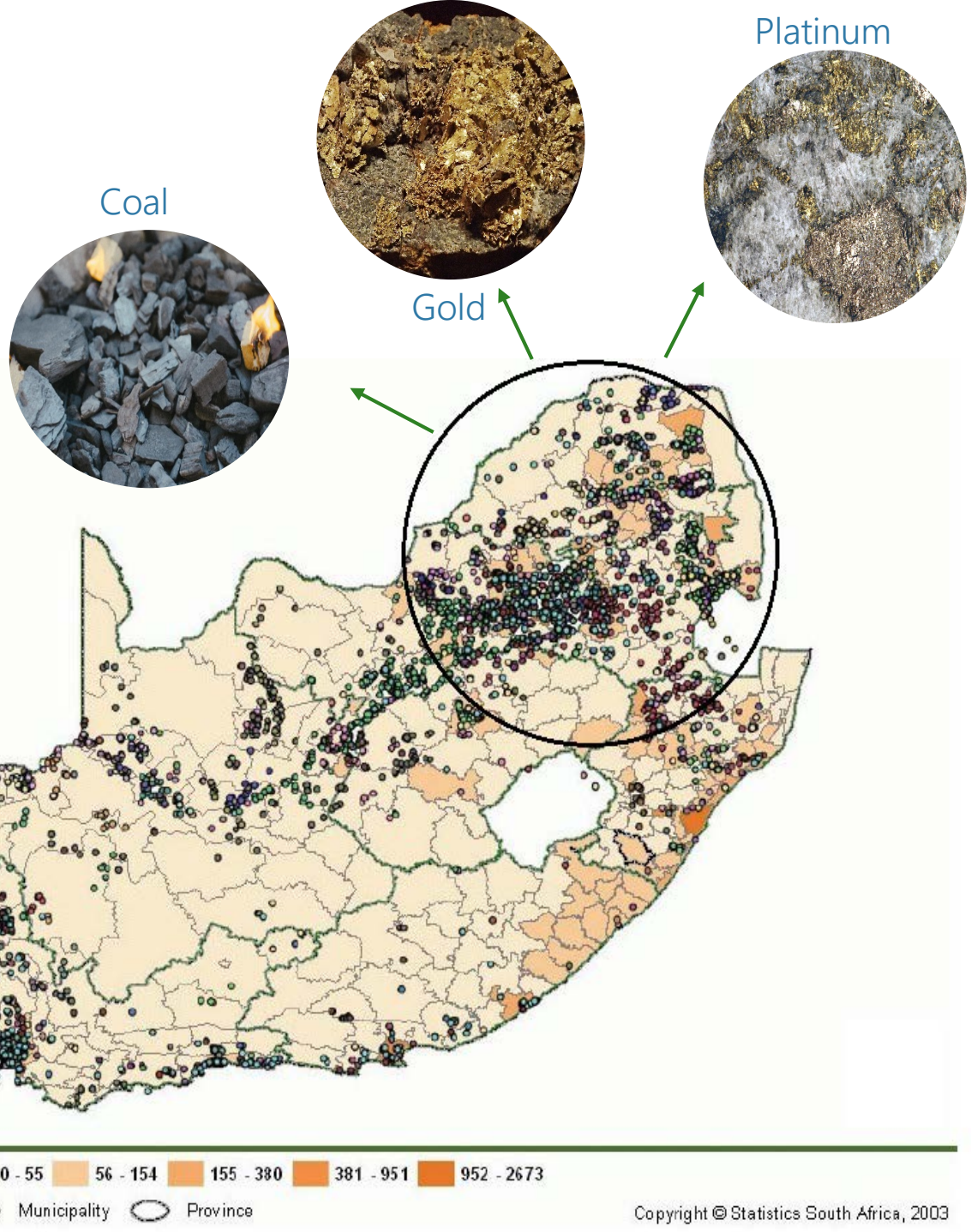
Scoping study and investigation in Carletonville, Rustenburg & Witbank mining areas

Average rainfall: 100 – 200 mm per annum

Average temperature: 7 – 32 ℃

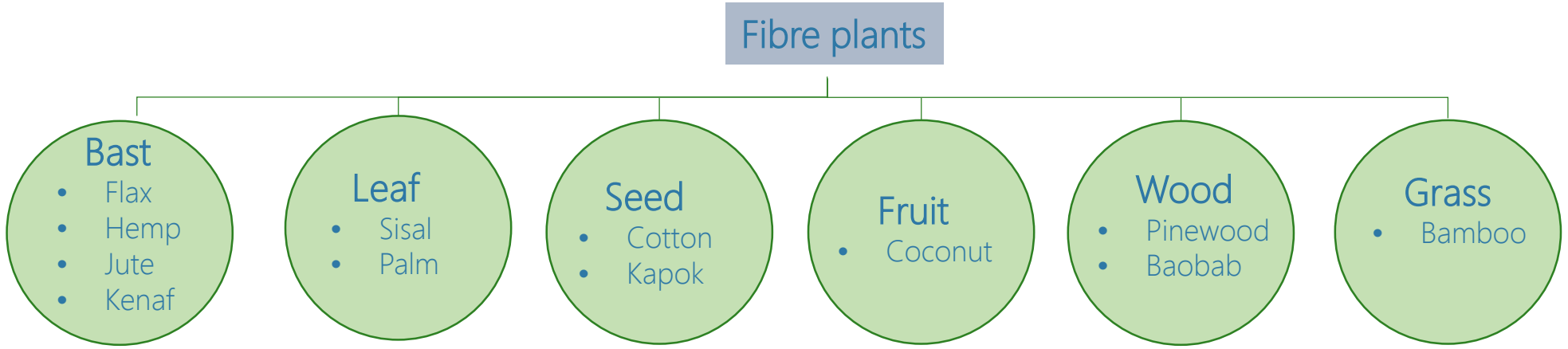
Soil pH: 5.5 - 7

Topsoil texture: Clay-sandy-loamy



Scoping study and investigation in South African mining areas

Overview and selection of fibrous plants in South Africa



Criteria for plant selection for example sites

- Non-invasive and/or indigenous
- Preferred soil type
- Temperature tolerance
- pH tolerance
- Multi-product possibility

Plant selection criteria

Fibrous plants selection

Bamboo balcooa, flax, hemp, kenaf and sisal

- Higher metal concentration ability
- Metal selectivity
- More specific metal bioconcentration sites
- Wider range of fibre and seed based products
- Grow in warmer temperatures
- Relatively easier to cultivate








Bambusa balcooa	Flax	Hemp	Kenaf	Sisal
400 – 5400 mm	450 – 750 mm	500 – 700 mm	240 – 490 mm	500 – 1500 mm
9 – 35 ° C	10 – 27 ° C	19 – 23 ° C	15 – 27 ° C	10 – 32 ° C
12 – 18 tons/ha	~ 2 tons/ha	2.2 – 8 tons/ha	5 – 7 tons/ha	1 – 4 tons/ha
5 – 6 years	100 days	120 days	90 – 125 days	2 – 4 years
Pb, Zn, Cr, Fe	Pb, Zn, Cd	Ni, Pb, Cd, Zn, Cu	Pb, Zn, Cd	Zn, Cd, Cu

Selected fibrous plants for detailed study

- A wider range of products
- Stronger fibre (tensile strength)
- Fibre type :
  Hemp & Kenaf – Bast fibres

  Bamboo – Woody grass

Hemp

Kenaf

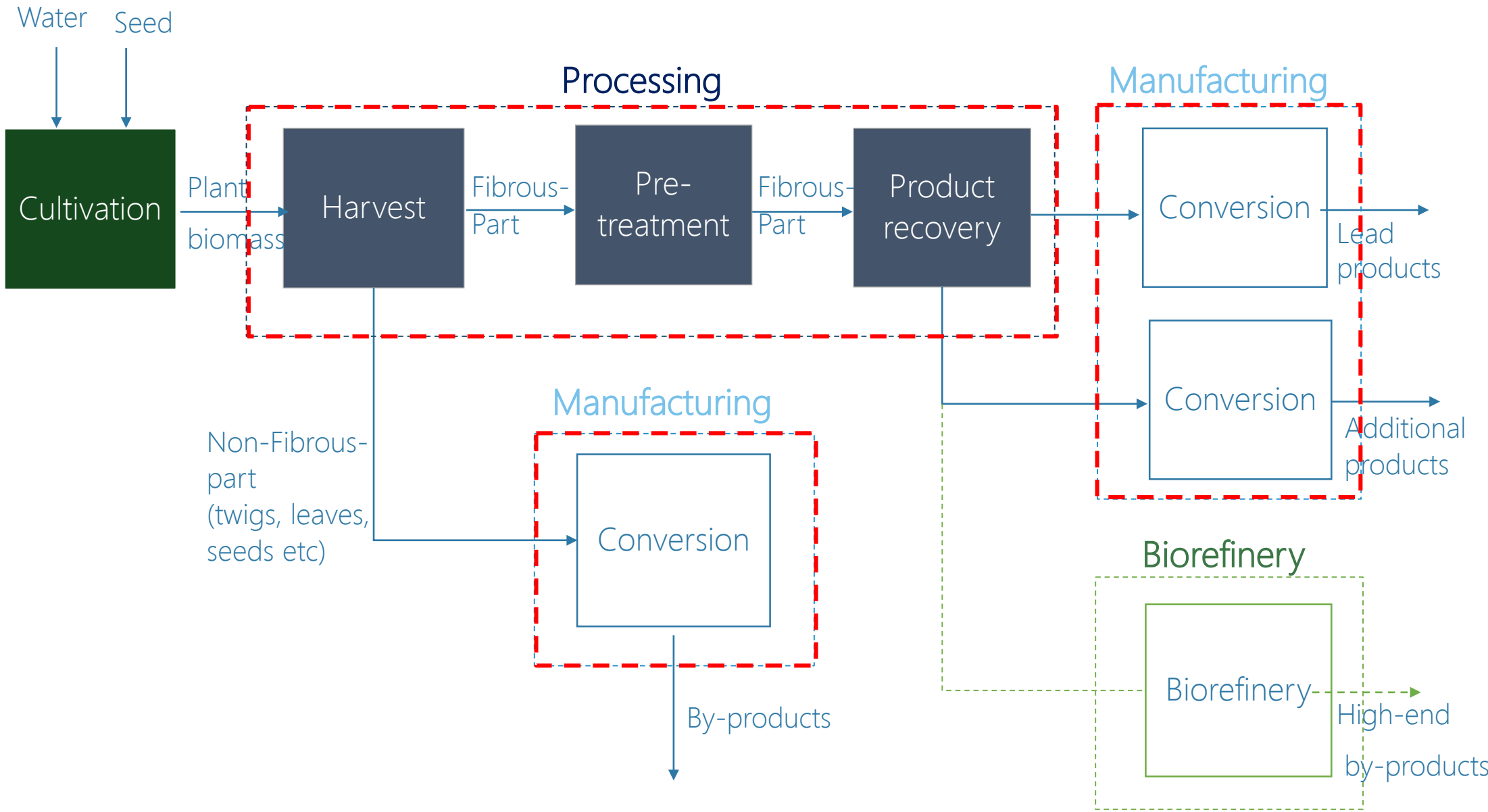
Bamboo

Scoping study and investigation in South African mining areas

Limitations and challenges

- Lack of top soil, organic matter and good microbial dynamics on degraded land
- Metal accumulation in fibrous plants tend to be low
- Metals can accumulate in harvestable parts of plants
- Product quality & safety would be an issue
- Return on investment may take long for some of the crops

Potential System Flowsheet



Bast fibre plant processing

Bast fibre crop-to-product profile

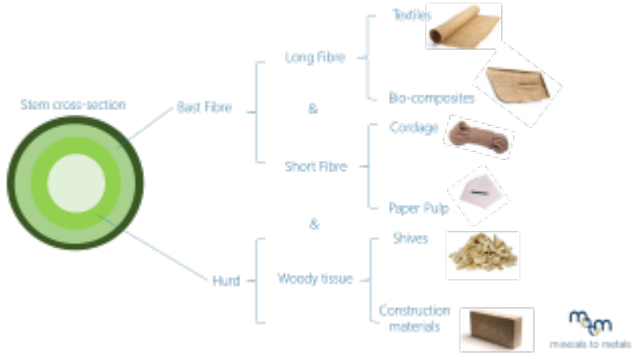
ENTIRE PLANT

Energy

Example - Bioethanol

STEM

Fibre + Woody tissue



Example: Hemp

SEEDS

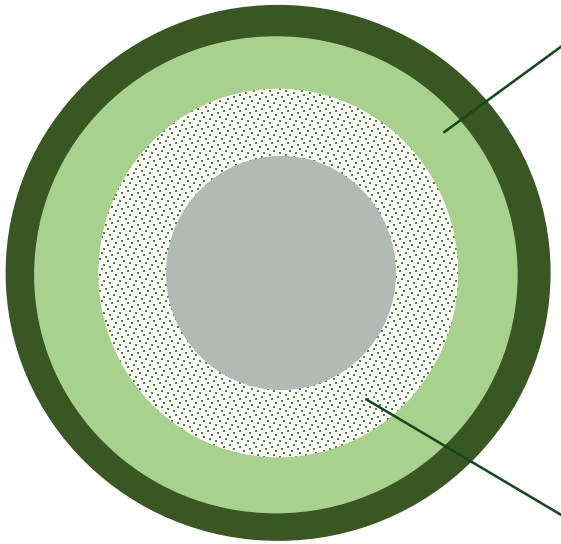
Seeds or Oil

LEAVES

Leaves or Medicine

minerals to metals

Bast fibre
stem cross-section



Bast Fibre

Hurd

Intermediates

Long Fibre

&

Short Fibre

&

Woody tissue

End-products

Conventional textiles

Bio-composites

Cordage

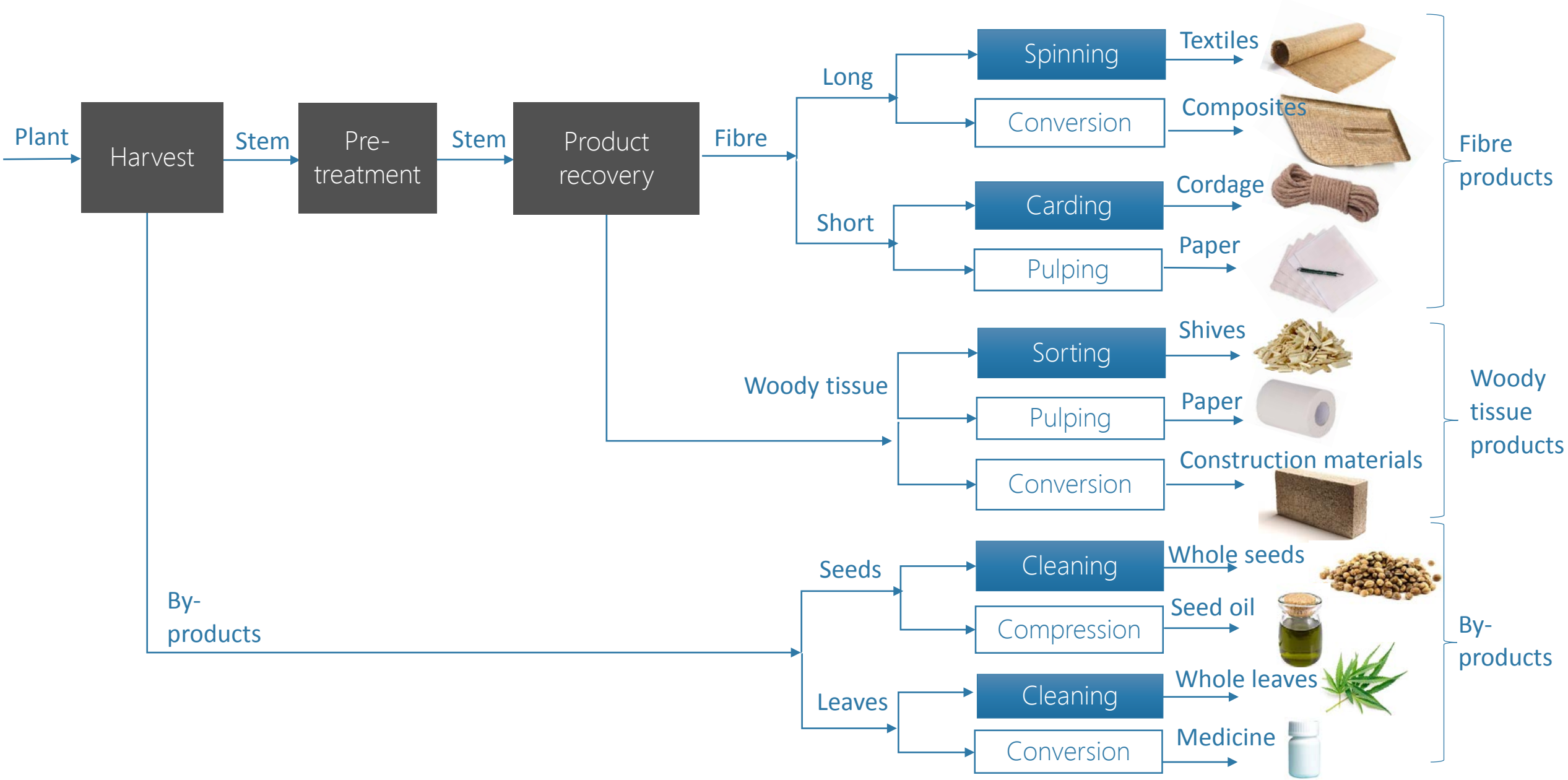
Paper Pulp

Shives

Construction materials

minerals to metals

Bast fibre multi-product flowsheet options



Bamboo plants and processing

Bamboo crop-to-product profile

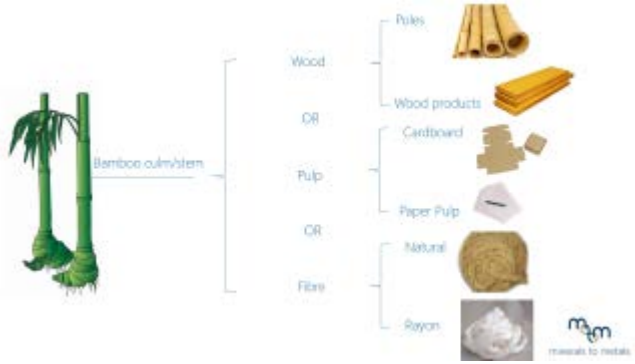
ENTIRE PLANT

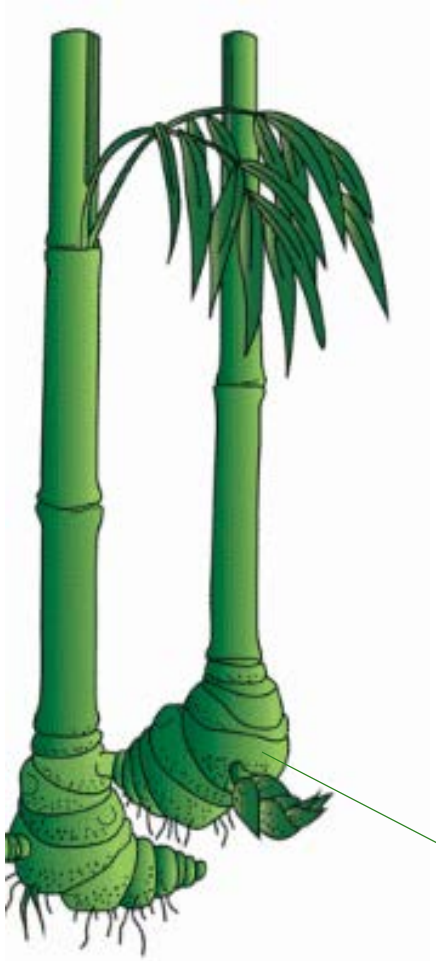
Energy

Example - Biochar

STEM/CULM

Wood or Fibre or Pulp





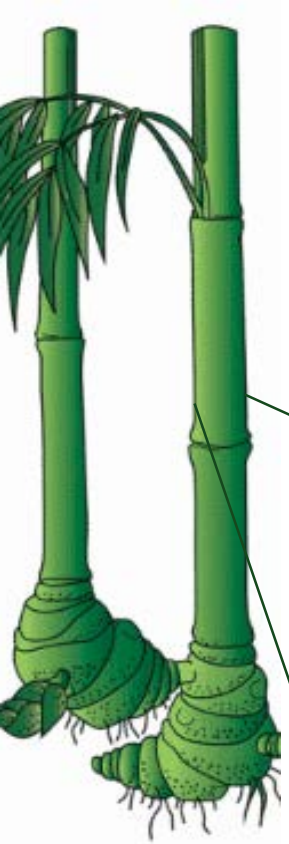
BRANCHES

Household wood products

SHOOTS

Vegetable

minerals to metals



Bamboo culm/stem

Intermediates

Wood

OR

Pulp

OR

Fibre

End-products

Poles

Wood products

Cardboard

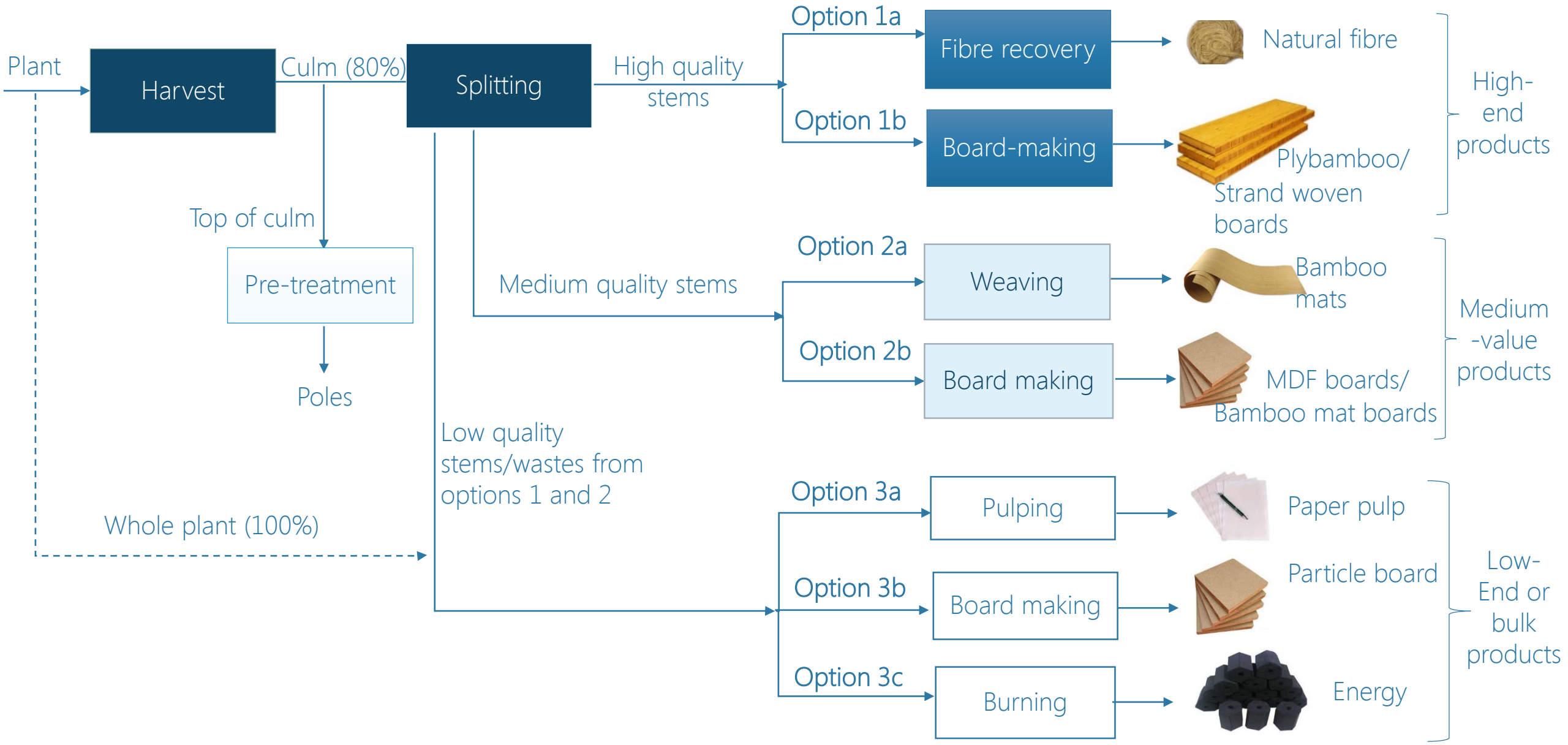
Paper Pulp

Natural

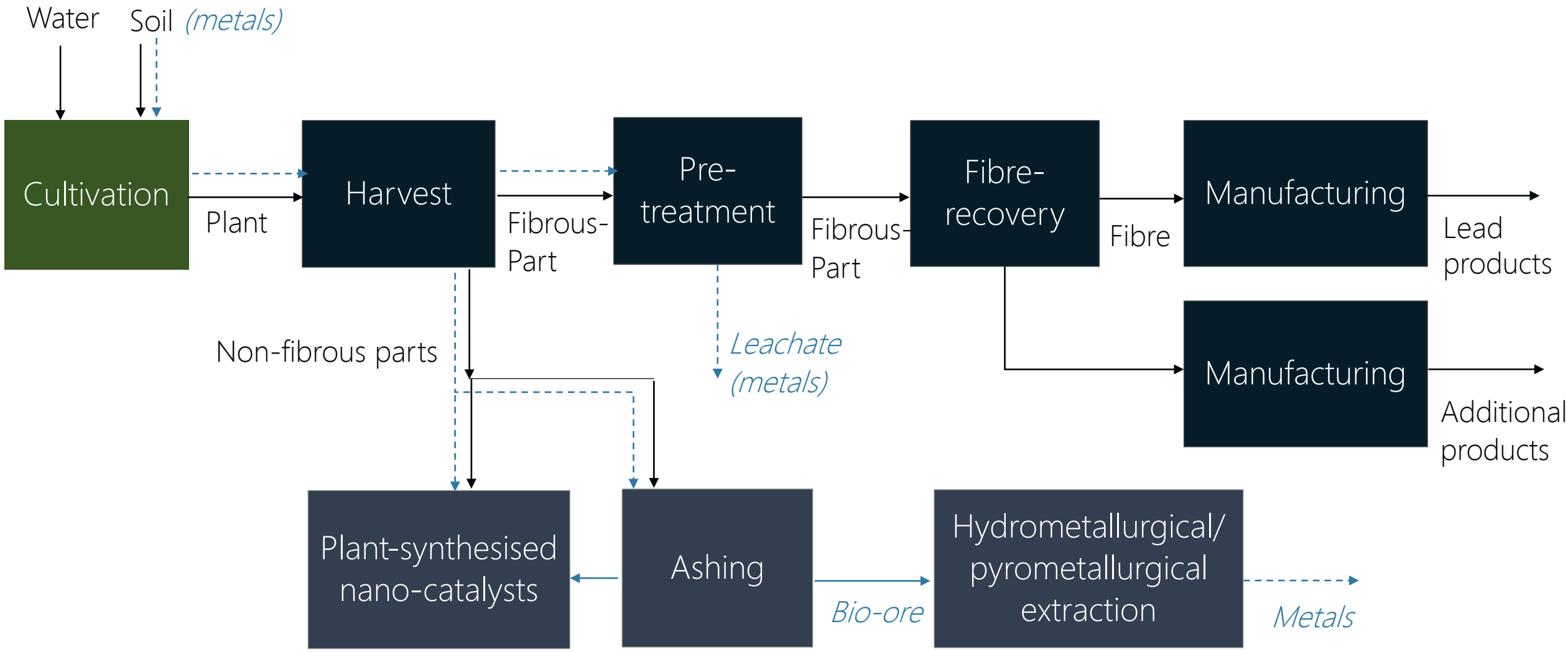
Rayon

minerals to metals

Bamboo multi-product processing scenarios



Potential integrated metal recovery process



Summary of fibre processing and product selection

Summary

- All the fibre-producing plants can generate multiple products however, the range of products differ for the different plant types.
- Selection of product recovery and treatment processes is highly dependent on desired lead and additional product types.
- Exploitation of fibre-based plants and industry development will also depend on the socio-economic and environmental drivers.
- Integrating metal recovery may limit product quality and the capability of the fibre products.

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minerals to metals

MINERAL LAW
IN AFRICA