Re-use of Residual Hemp Biomass from Textile Production

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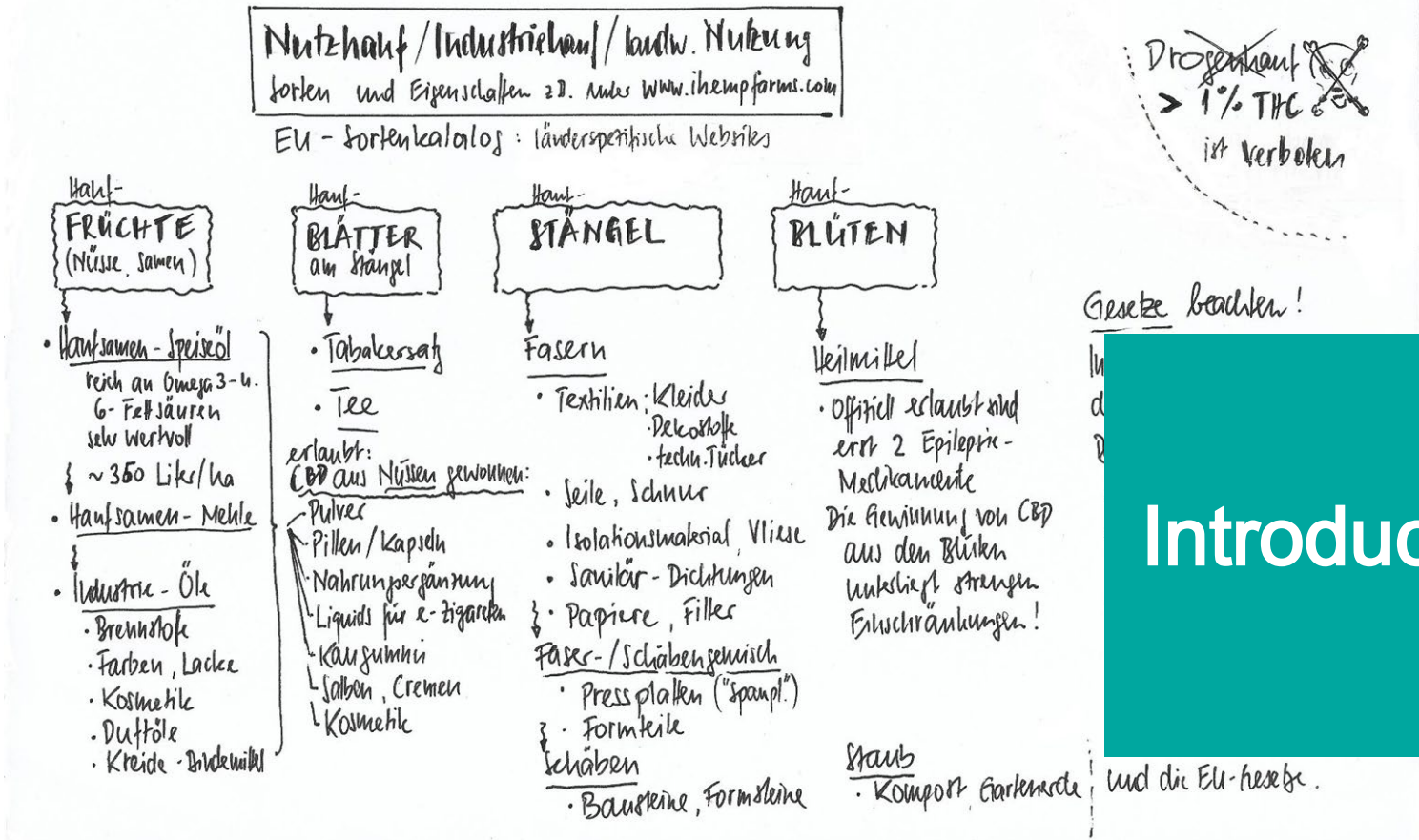
TEXTIL GLÄRNISCH

Introduction



Materials

First class straw
pure fiber

Second class straw
coarse fiber

Third class straw
50% fiber + 50% wood

Chemical composition of hemp straws

Hemp Straw	Fiber part	Woody part
Cellulose (%)	73-77	48
Hemicellulose (%)	7-9	21-25
Lignin (%)	4-6	17-19

Applications

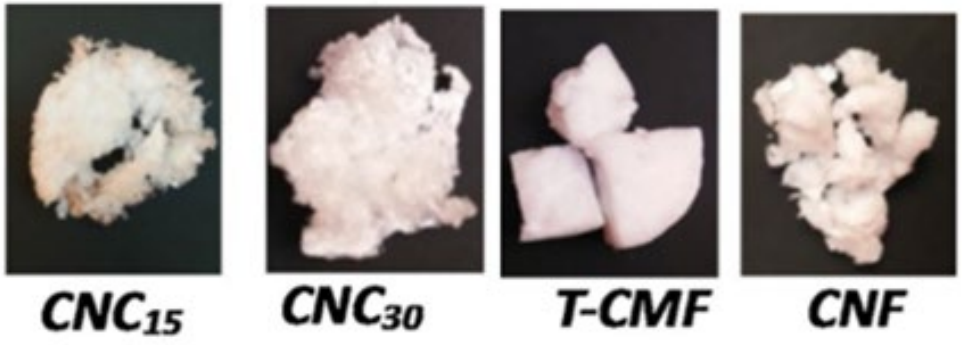
Hemp Straw

long fibers

- quality papers
- technical fibre bundles
- textiles & tech-textiles
- composites, automotive

short fiber, wood

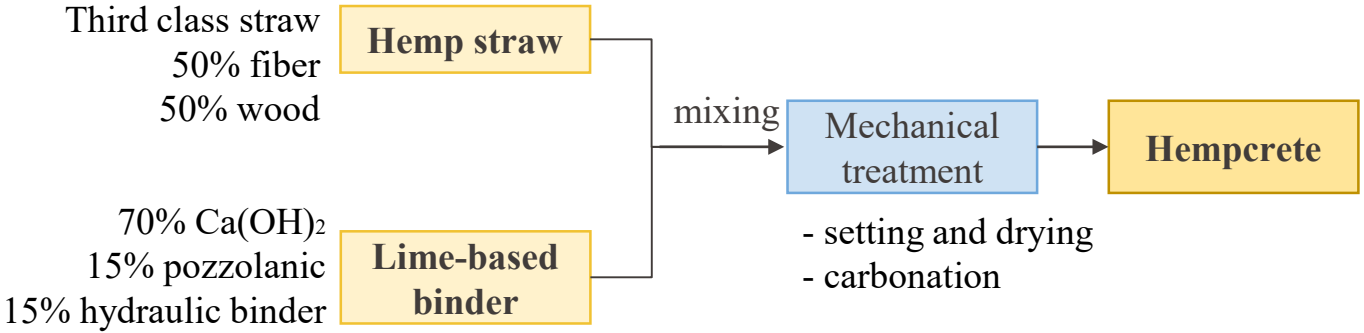
- construction materials
- paper
- animal bedding, absorbent, mulch
- energy
- biodiesel, biofuel
- environment



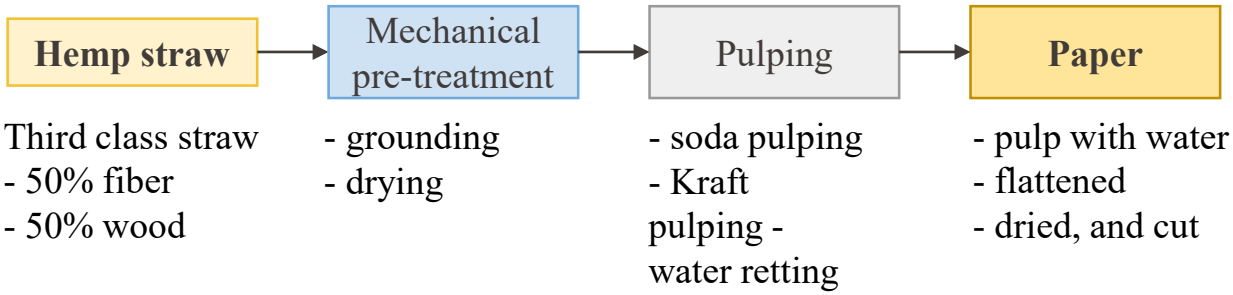
Potential Products

Traditional Products

Hemp Concrete



Hemp Paper



New Product

➢ Hemp-based CNF

Third class straw
- 50% fiber
- 50% wood

- grounding
- blending
- refining

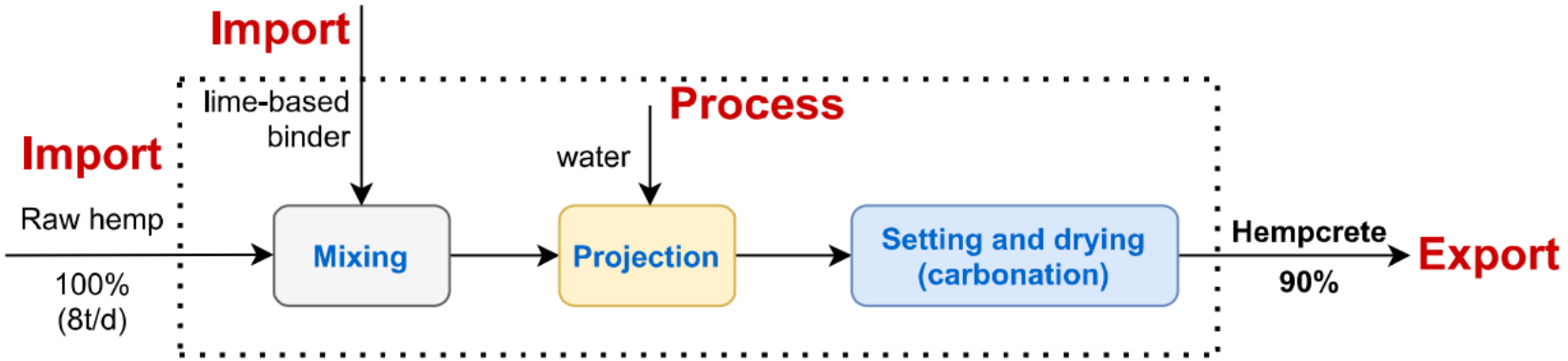
- alkaline
- ozonation

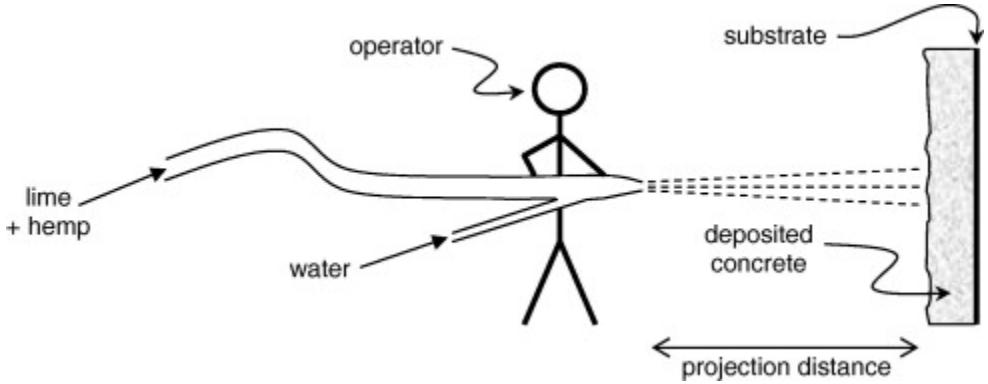
- bleaching
- agitation
- defibrillation

- a promising material
- high value
- emerging applications

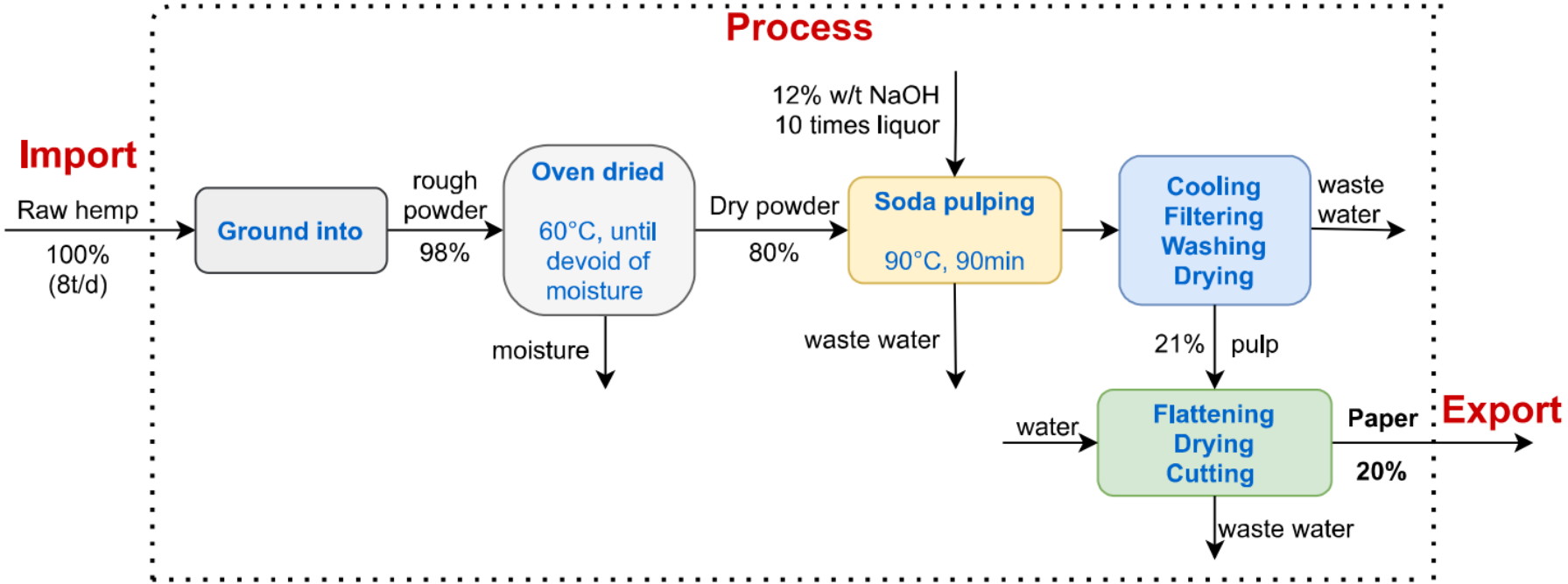
Design Pathways

Hemp Concrete

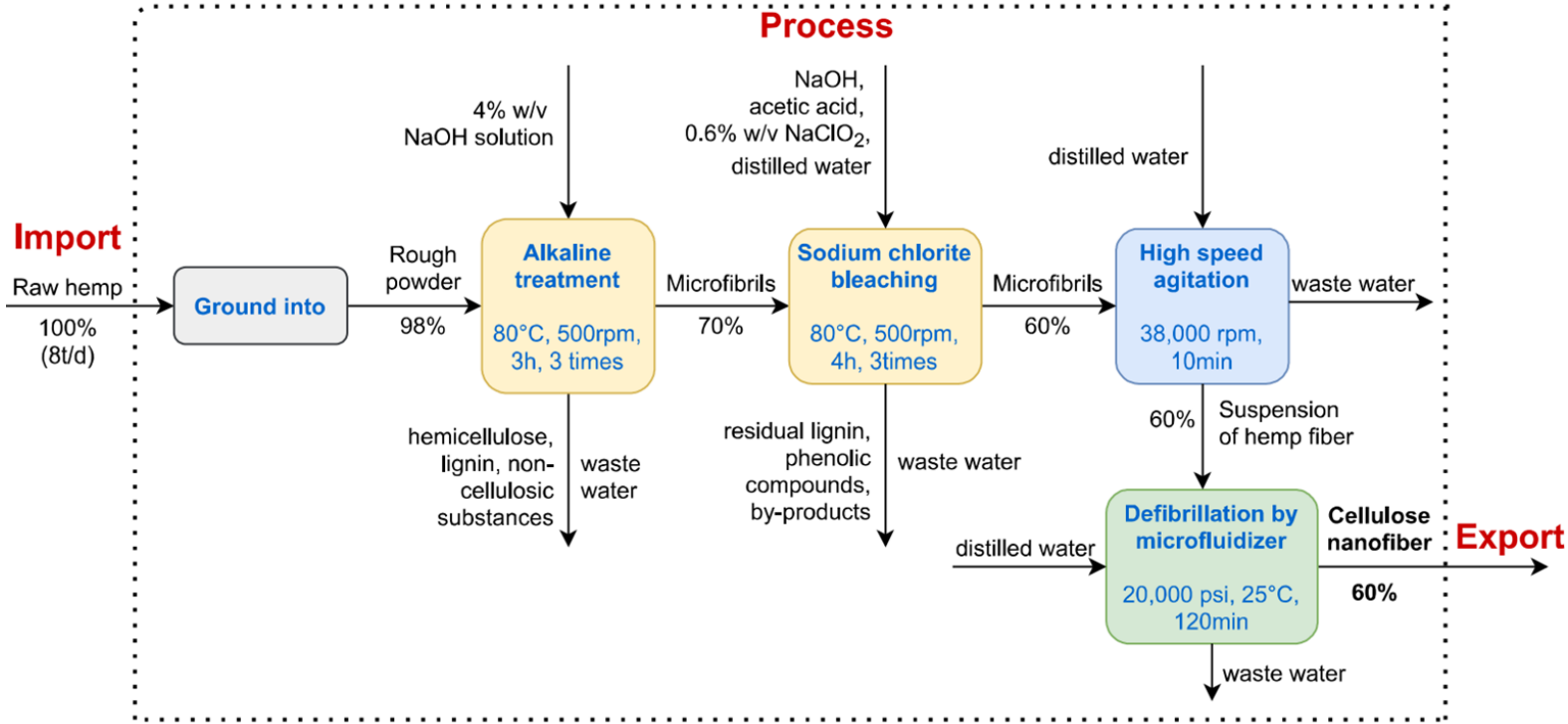




Hemp Paper


Process
Import
Raw hemp
100%
(8t/d)
Ground into
rough
powder
98%
Oven dried
60°C, until
devoid of
moisture
moisture
Dry powder
80%
12% w/t NaOH
10 times liquor
Soda pulping
90°C, 90min
waste water
Cooling
Filtering
Washing
Drying
waste
water
21%
pulp
water
Flattening
Drying
Cutting
Paper
20%
Export
waste water

Hemp -based CNF



Calculation

Hemp Concrete

	Consumption (ton/ ton hemp)	Unit price (CHF/ ton)	Cost (CHF/ ton hemp)
Pozzolanic	0.4	40	16
Hydraulic binder	0.4	40	16
Calcium hydroxide	1.5	55	82.5
Water	3.2	0.5	1.6
total	-	-	116.1

Hemp Paper

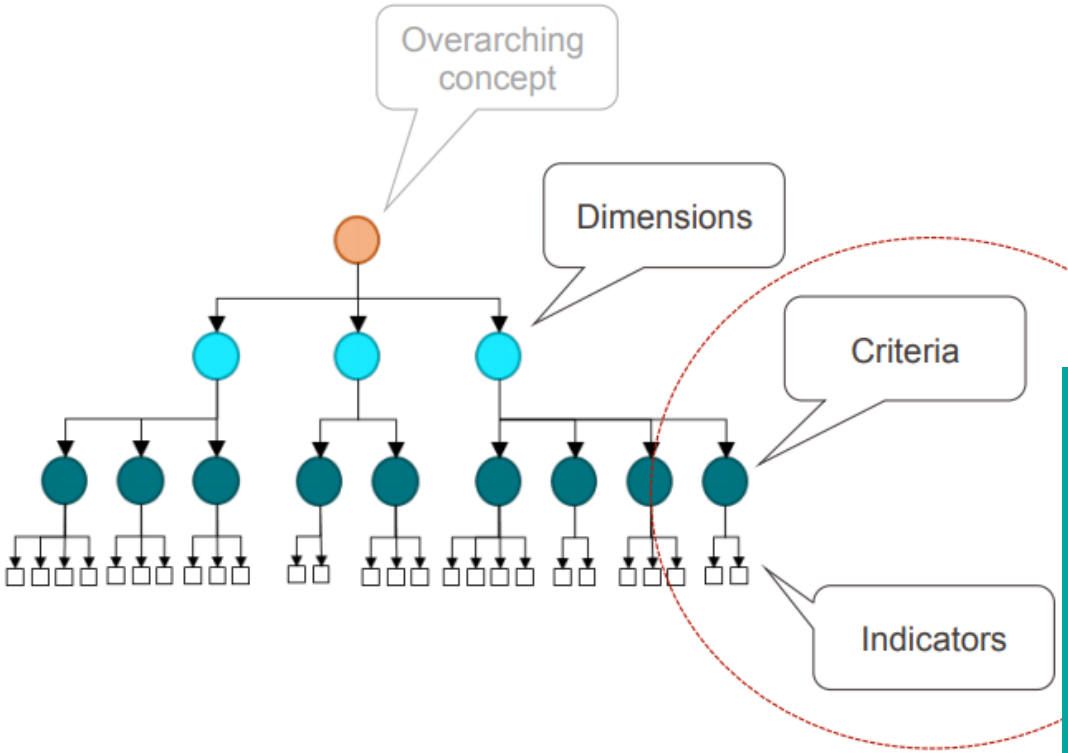
Item	Consumption (ton/ton hemp)	Unit price (CHF/ton)	Cost (CHF/ton hemp)
NaOH	0.48	300	144
Na_2S	0.48	300	144
Water	10	0.5	5
total	-	-	293

Calculation

➢ Hemp-based CNF

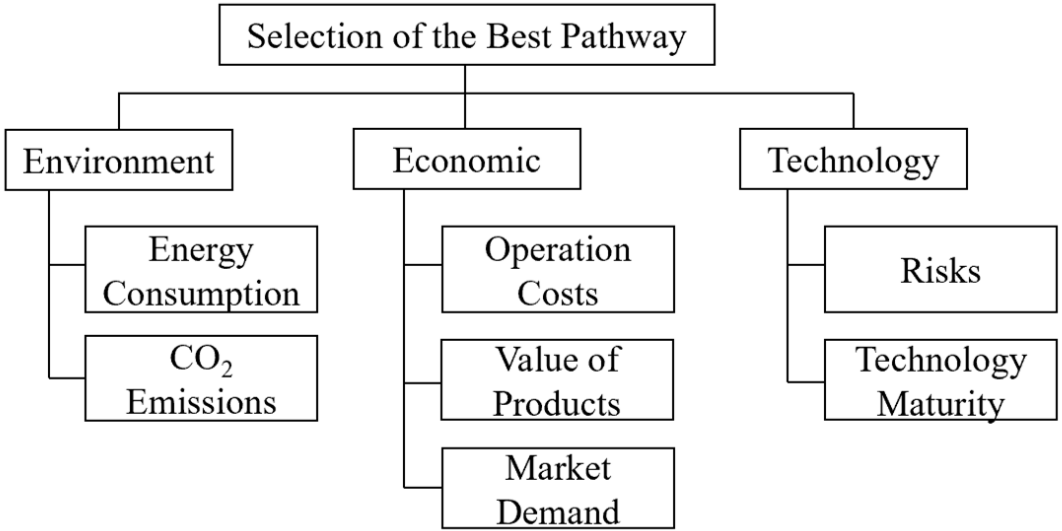
Stage	Water (m^3)	NaOH (ton)	$NaClO_2$ (ton)	HAc (m^3)
Pretreatment	6	0.24	-	-
Bleaching	6	0.054	0.036	0.15
Agitation	85	-	-	-
Defibrilation	85	-	-	
total	182	0.294	0.036	0.15

	Consumption (ton/ ton hemp)	Unit price (CHF/ ton)	Cost (CHF/ ton hemp)
Water	182	0.5	91
NaOH	0.294	300	88.2
$NaClO_2$	0.036	2000	72
HAc	0.015	500	7.5
total	-	-	258.7



Multi -Criteria Analysis

Identify Criteria



Standardization Scale

Extremely bad	Very bad	Bad	More or less bad	Moderate	More or less good	Good	Very good	Extremely good
1	2	3	4	5	6	7	8	9

Evaluation Matrix

Criteria		Goals	Units	Alternatives		
				CNF	Hemp concrete	Paper
Environment	Energy consumption	↓	MJ/ton	87000	40.98	12910
	CO_2 emissions	↓	kg $CO_{2,eq}$ /ton	790	-0.12	300
Economic	Operation costs	↓	CHF/ton	431.2	19	293
	Value of products	↑	CHF/ton	3000	92.2	840
	Market demand	↑	-	8	5	4
Technology	Risks	↓	-	8	2	5
	Technology maturity	↑	-	2	8	7

- Environment

  LCA from literature
- Economic

  Mass flow analysis
- Qualitative criteria

  Standardized scale

Normalization Evaluation Matrix

Criteria		Goals	Alternatives		
			CNF	Hemp concrete	Paper
Environment	Energy consumption	↓	1	9	7
	CO_2 emissions	↓	1	9	5
	Operation costs	↓	1	9	3
Economic	Value of products	↑	9	1	4
	Market demand	↑	8	5	4
Technology	Risks	↓	8	2	5
	Technology maturity	↑	2	8	7

- standardization scale
- linear regression

Weighted Matrix

Domain	$Weight_1$	Criteria	$Weight_2$	CNF	Hemp concrete	Paper
Environment	0.4	Energy consumption	0.5	0.2	1.8	1.4
		CO_2 emissions	0.5	0.2	0.2	1
		Operation costs	0.4	0.16	0.16	0.48
Economic	0.4	Value of products	0.4	1.44	1.44	0.64
		Market demand	0.2	0.32	0.32	0.2
		Risks	0.6	0.96	0.96	0.6
Technology	0.2	Technology maturity	0.4	0.16	0.16	0.56
Total Score				3.44	4.56	4.88

- Weighted score = Score of normalized table * Weight1* Weight2

Conclusion

- ➢ **Production of CNF performs worst**
  - high operation and energy cost
  - high value
  - emerging market, a promising pathway
- ➢ **Producing concrete is simple and traditional**
  - low cost and environment impact
  - little economic benefit
- ➢ **Production of paper performs the best**
  - the most suitable pathway nowadays

Thanks for your attention!

Q&A session