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Hemp-lime Insulation: A Climate Friendly Building Material

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1. Motivation

Reduce green house gasses in atmosphere

- Reduce emissions
- Increase sequestration

Oregon's Climate Action Plan

- Clean buildings
- Natural and working lands

Hemp-based construction materials

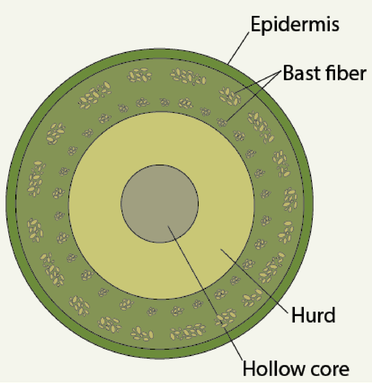
2. Industrial Hemp

What is Industrial hemp?
A variety of Cannabis Sativa L. with no more than 0.3% delta-9 THC

Industrial hemp varietals:
1) Flower
2) Seed/grain
3) Fiber

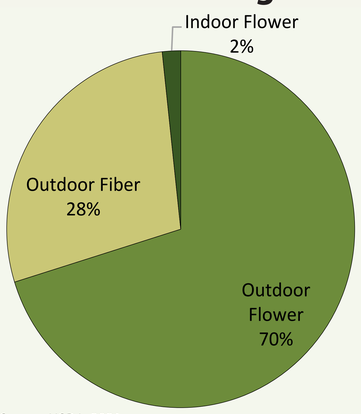
Environmental benefits:
1) CO_2 sequestration
2) Phytoremediation
3) Improves soil quality

Cross Section of Hemp Stalk



3. Oregon's Hemp Industry

Acres of Hemp Grown in Oregon



Source: USDA, 2021

Flower

- **Consumer CBD products**
- **Growth phase** limited by over saturated supply
- High margins
- High competition

Fiber

- **Industrial products**
- **Growth phase** driven by demand for sustainable materials
- Low margins
- High competition

4. Hemp-lime Insulation

Hemp-lime: A non-structural insulation material made from hemp hurd, a lime-based binder, and water

International Residential Code Comission Proposal RB316-22:
- Defines requirements and limitations of hemp-lime insulation

Hemp-lime characteristics: Non-toxic, mold resistant, improves acoustics of structure, multiple installation methods and applications

5. Research Questions

How much CO_2 is emitted by 1 tonne of hemp-lime insulation?

What factors impact CO_2 emissions?

6. Methodology

1) Meta-analysis of existing literature
2) Multiple variable sensitivity analysis
3) Lifecycle assessment of CO_2 emissions

7. Hemp-lime Lifecycle

Production of Raw Materials

Hemp hurd	Lime binder
Cultivation	Extraction
Harvest	Calcination
Transportation	Packaging
Decortification	Transportation
Transportation	

Inputs that impact CO_2

Emissions	Sequestration
Fertalizer	Industrial hemp
Agricultural equipment	
Transportation distance	
Transportation vehicle	
Decorticator machine	
Calcination of limestone	

Production of Hemp-lime

1:1 or 1:2 ratio → Hemp hurd:lime ratio

Installation

Masonry Form work Spray in

Use

100 year lifespan → Lime binder

8. Results

	Scenario 1	Scenario 2
Fertalizer	Good agricultural practice	Pig slurry
Yield estimate (tonne dry hemp/ha)	2.3	2.3
Hemp species	Carmagnola (Fiber)	Carmagnola (Fiber)
Hemp cultivation	ploughing to bailing	ploughing to bailing
Transportation vehicle	Conventional Class 8	Fully Electric Class 8
Warehouse to farm (empty)	100	0
Farm to processor (full)	100	0
Decorticator	FiberTrack 660	HurdMaster (Micro)
Energy source	Hydropower	Hydropower
Warehouse to processor (empty)	100	25
Processor to point of sale (full)	100	25
Binder	Hyrdrated lime	Hyrdrated lime
Warehouse to farm (empty)	100	50
Farm to processor (full)	100	50
Mixing (hemp:binder)	1:2	1:1

		Scenario 1		Scenario 2	
(1 tonne)	**Emission Variable**	**Sequestration**	**Emission**	**Sequestration**	**Emission**
Dry hemp	Cultivation	-1.333	1.117	-1.333	0.848
	Farm machinery		0.005		0.005
	Transportation		0.037		0.000
Hemp hurd	Decorticator		0.003		0.001
	Transportation		0.037		0.009
Binder	Production		0.001		0.001
	Transportation		0.037		0.003
Hemp-lime	**Hemp hurd**	-0.453	0.408	-0.667	0.428
	Hyrdrated lime	-0.0003	0.025	-0.0002	0.002
	Total CO_2 emissions	**-0.021 tonnes**		**-0.237 tonnes**	

9. Conclusions

- **Hemp-lime is carbon negative**
- **Scenario 1 is estimated to emit an additional 0.216 tonnes of CO_2**
  - Fertalizer
  - Transportation distance and vehicle
  - Hemp:binder ratio

Acknowledgments

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References:
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6) U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks, Tables A-32, A-38, and A-232 **7) James Vosper**, The Role of Industrial Hemp in Carbon Farming, GoodEarth Resources PTY Ltd. **8) Jnzl's Photos**, Hempcrete wall at CDL Green Gallery