World Hemp Forum

Les rencontres du chanvre industriel

Forum des chercheurs Researchers' Forum







Troyes, november 19th 2024



Walloon Agricultural Research Centre To address today's questions and to prepare tomorrow's challenges www.cra.wallonie.be Dr ir JM ROMNEE



Wallonie recherche CRA-W

Walloon Agricultural Research Centre

Introduction

From a microbiological point of view, what happens in soil when bioactive compounds leach from plants into soil ?



Retting



Beniko leaves : 55 mg·g⁻¹ (Sum of CBL, CBC, CBD, Δ 9-THC, Δ 8-THC, CBG)





Mulch for crops



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Material and method

Hemp sample : Autopower (Seeding on May 16 2024 -Greenhouse transplantation on June 6 -12 2024 - Sampling on August 7 2024)



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COMPO SANA as soil

Biolog EcoPlate[™] (31 carbon sources repeated 3 times by plate)



	1	2	3	4
А	Water	β-Methyl D- Gucoside	D-Galactonic Acid γ-Lactone	L-Arginine
в	Piruvic Acid Methyl Ester	D-Xylose	D-Galacturonic Acid	L-Asparagine
С	Tween 40	i-Erythritol	2-Hydroxy Benzoïc Acid	L-Phenylalanin
D	Tween 80	D-Mannitol	4-Hydroxy Benzoïc Acid	L-Serine
Е	α -Cyclodextrin	N-Acetyl-D- Glucosamine	γ-Amino Butyric Acid	L-Threonine
F	Glycogen	D-Glucosaminic Acid	Itaconic Acid	β-HydroxyGlycy L-Glutamic Aci
G	D-Cellobiose	Glucose 1- Phosphate	α-Keto Butyric Acid	Phenylethyl- amine
н	α -D-Lactose	D,L-α-Glycerol Phosphate	D-Malic Acid	Putrescine



Substrate groups

Amines and amids Amino acids Carbohydrates Carboxylic acids Polymers



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Material and method



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 A_0 : choose minimum absorbance (A1:H4) instead of water absorbance (A0) to avoid negative values



AWCD

Results





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Results

AWCD Well index - PCA



Projection similar to that obtained for the AWCD :

- "Soil + Flowers" group perfectly isolated
- "Soil" group isolated from "Soil + Activated Silica", "Soil + Silica + Extract" and "Soil + Flowers after extraction" groups
- Two groups for "Soil + Flowers after extraction". Possible explanation : incomplete extraction for the second flower
- However, the "Soil +Silica + Extract" group is different from the other groups



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And if we go back to the field ...



Grass has been sown throughout the field. And to date, the grower has not noticed anything special in terms of grass growth (intensity, density, colouring, etc.) in the area corresponding to the CBD hemp crop compared to the rest of the field.

However, if we look at the data obtained by satellite (<u>https://viewer.terrascope.be/</u>) ...



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And if we go back to the field ...

Sentinel2 LAI filter (quantifies the area of green leaves per m²)



July 15th 2024



September 21st 2024

Sentinel2 FAPAR filter (quantifies photosynthetic activity)







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Conclusions and perspectives

Conclusions

- Effective effect of hemp inflorescence bioactive compounds on soil microbiology : intensification of total carbon source consumption, demonstrated using Biolog Ecoplate [™];
- Effect demonstrated in the field using satellite imagery : after 10 months, leaf density is still lower, and photosynthetic activity is lower than in the rest of the plot

And into the future ...

- Identification of the groups of micro-organisms and the mechanisms involved : selection by the addition of a particular metabolite, elimination by the bactericidal action of the compounds present, ...
- Monitoring of the cultivated land under real conditions : microbiological balance, influence of the type of soil, ...



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And for your questions ...

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Thank you for your attention Merci de votre attention Muchas gracias por su atención Herzlichen Dank für Ihre Aufmerksamkeit Grazie per la vostra attenzione спасибо за Ваше внимание ຂອບໃຈສໍາລັບຄວາມສົນໃຈຂອງເຈົ້າ Bedankt voor Uw aandacht Takk for oppmerksomhet Děkuli za pozornost Hvala za vaso pozornost ご清聴ありがとうございました



Hemp: A Sustainable Fibre with Multiple Applications

World Hemp Forum, Troyes

19th November 2024

Authors: João Mariz, Catarina Ramoa, Lúcia Rodrigues and Carla Joana Silva

> REPÚBLICA PORTUGUES/





Introduction to CITEVE



Technological Centre for the Textile and Clothing Industries of Portugal

Commitment to Quality, Compliance and Innovation



Services

Testing

Product & Process Certification

Research, Technology Development & Engineering

Sustainability, Bio & Circular Economy

Manufacture Digitalization & Industry 4.0

High Level Training & Coaching

Support to Innovation Capacities & Entrepreneurship

International Consultancy Design & Fashion Intelligence







Market oriented

Fashion

Sports

Defence and PPE

Mobility & Transport

Workwear

Health & Well-being

Architecture & Construction







Project Scope

l.









From nature, in a sustainable and circular way, to people.

NPRR

Bioeconomia

CITEVE

l.





Hemp in The Textile Industry

Consorsium:







Hemp Cultivation

Objective:

Development and Study of Hemp Crops:

- Different Varieties
- Analyses of Agricultural Conditions: Yield, Resistance, Water Consumption
- Impact of Geographical Environments: Soil and Climate Conditions















citeve

Hemp Value Chain



Adapted from: https://doi.org/10.3390/textiles4020011



citeve

Hemp Value Chain



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Hemp Fibre Extraction

Laboratory Scale Machinery of Hemp Fibre Extraction



Breakin g

Scutchin g

Hackling Under Development















Hemp Fibre Cottonization

Mechanical Cottonization of Hemp Fibres



Biological Treatment of Hemp Fibres







Bioeconomia

FUNDO -/mbhental



Funded by the European Union

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Hemp Pilot Developments

CITEVE's Pilot-Hemp Developments



Ring-Spinning Hemp-based Yarn



Needlepunched Hemp-based Nonwoven



Bioeconomia FUNDO → MBHENTAL







Main challenges

Main challenges

- Limitations of knowledge about hemp cultivation and fibres extraction process and involved machinery
- Lack of communication between the different players in hemp valuechain
- Minimizing the variables of all process mainly in Retting process
- Lack of Life Cycle Assessment (LCA) studies of hemp value-chain (from field to final products)







Oportunities/Future

Opportunities for Hemp's Futures

- Sustainability continues to grow as a major priority
- New Projects of R&D to respond to certain bottlenecks
- Development of new hemp-dedicated processes



- Increase in cultivated area, and recovery of lost knowledge, through training programs
- Possibility of obtaining seeds and fibres from the same plant









Thank You for Your Attention

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World Hemp Forum

Commingling of hemp-based yarns for the continuous additive manufacturing to achieve improved impregnation quality

Xikun Wu, Geoffrey Ginoux, Chaimae Laqraa, Damien Soulat, Samir Allaoui

19/11/2024









Horizon 2020 European Union Funding for Research & Innovation

Communication content

Context, issue & objectives

Methodology

- Process
- Characterization

Results & discussion

- Microstructure and formulation
- Mechanical performance
- Conclusion & perspectives

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– URCA | GEMTEX – UDL

| 19/11/24 |

| ITheMM

World Hemp Forum Xikun WU *et al.* | ITh

Context, issue & objectives





Matsuzaki et al. (2016). Scientific Reports, 6, 23058



• Additive manufacturing (AM) (= 3D printing)

- Geometric freedom
- Fast production for small series
- But diminished properties compared to conventionally manufactured parts¹

Materials development needs

- Higher mechanical performance
- Eco-friendly materials (reinforcement + matrix)

Technological locks: Impregnation quality

- Pre-impregnation with thermoset
- Commingling of untwisted and smooth synthetic fibers²

Non-eco-friendly

What do we want?

Developing new plant-based yarns using available and eco-friendly fibers, adapted to the AM of continuousreinforced biocomposites, having effective impregnation.

Methodology



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Microstructure and formulation

Results & discussion



- Longitudinal voids
- Distribution of fiber orientations (± 20°) (Hemp yarn: 39 tpm)

Volume fraction	Hemp YRC	Hybrid YRC	
Hemp	33%	26%	- 21%
PLA	41%	60%	
Void	26%	14%	-46%



- Bubble-like voids
- Unidirectionally oriented fibers (0°) (Hybrid yarn: 200 tpm)

	Increase in polymer mass fraction (between the fibers) → Void filler (↗ impregnation) and lubricant-like agent		
Less	fiber, but less void!	Antagonistic effect: Mechanical performance?	

Mechanical performance



Properties	Hemp YRC	Hybrid YRC
<i>E</i> ₁ (GPa)	9.6 ± 0.5	15.2 ± 0.7
<i>E</i> ₂ (GPa)	5.7 ± 0.2	8.2 ± 0.2
$\sigma_{_{M}}$ (MPa)	122 ± 3	137 ± 7
ε _r (%)	2.2 ± 0.1	1.4 ± 0.1

Results & discussion



Hemp → hybrid YRC: From pseudo-ductile to fragile behavior

- Early and neat transition from E₁ to E₂: 0° alignement +
 > fiber/fiber interactions and ↗ fiber/matrix interactions
- Around 50% increase in stiffness If considered without void: scaling factor $K = 1/(1 - \Phi_{v,V})$ Around 30% increase in stiffness while having 20% less fiber
- Sharp rupture: crack propagation from matrix to fibers

Conclusion & perspectives

Hybrid vegetal fibers/thermoplastic fibers commingling for continuous AM of biocomposites









Aknowledgement









Horizon 2020 **European Union Funding** for Research & Innovation











ABSTRACT

This work clarifies the key concepts of **domestic Cannabis cultivation** at high altitudes (1600 m) in the Rif mountains of Morocco.

It addresses the question of **future value creation of this resource, legalized in 2024,** almost three years after the new Cannabis Law 13-21 came into force.

The new panorama places the historic farming region of "Beldiya" hemp in a vanguard position, that inspires the enhancement of its environmental and cultural potential, with corrective projects that are based on its own polyvalent resource.

"ETIOLOGIC ARCHITECTURE" refers here to the analysis of the causes, origins, or reasons behind the disturbance that need a constructive answer.



Etiologic architecture with Moroccan landrace hemp, restoring socio-cultural and agro-industrial scenarios

Monika Brümmer¹

¹ Architect, PhD. **CANNATEKTUM** habitat and materials science S.L., Guadix/Granada, Spain. Tel: **0034 686 385 567**, info@cannabric.com. **CEDRUS SATIVUS** Sarl, Issaguen/Al Hoceima, Morocco.



DAR AL KIF, hemp house built with materials, derived from Morrocan Landrace stem (2023)







L (1)



The preservation of the landrace, adapted to its physical and biological environment, advocates restoration of balance and stability in its historical farming region that has depended on the controversial illicit production of Cannabis for decades. This activity has had serious consequences for the environment, human progress and socio political inclusion of the region.

In addition, the one-sided, illicit exploration of Beldiya has created important quantities of left-overs [Brümmer et al., 2018], and hindered the development of agro-industrial projects that valorize the wasted material [Pacaphol and Aht-Ong, 2017]. Collecting and identifying the potential of landrace hemp and promoting its historical anchoring is a challenge [Clarke and Merlin, 2016], but iniciates its protection as a designation of origin to economically, environmentally and culturally benefit the region in question [Chouvy, 2023] and restore the associated ecosystems.









unvalued Cannabis agro-ressources



exclusion and delay



Etiologic architecture with Moroccan landrace hemp, restoring socio-cultural and agro-industrial scenarios Monika Brümmer, Architect PhD.; CANNATEKTUM habitat and materials science, S.L. (Spain); CEDRUS SATIVUS Sarl (Morocco) Sunimplant Landrace Hemp House Solar Decathlon Africa (2019)

INTRODUCTION (2)

Spite of Morocco's commitment to Marrakech and Paris agreements, training and promotion is crucial in the country to build expertise in building solutions that contribute to mitigate climate change [*Mghazli et al., 2024*].

Our first landrace hemp building SUNIMPLANT at the competition of Solar Decathlon in Africa, held 2019 in Morocco, was approaching not only a Net Zero Energy goal based on operational energy but also ensured that the building was optimized in terms of design and materials for reduced consumption.

The multiporous and vapor active hempearth envelope has proven a dynamic performance under South Moroccan summer conditions, showing a time lag of 9 hours [*Es-sakali et al., 2023*], damping temperatures 5 hours longer than a reference building at the same platform.



OBJECTIVES

• Creation of a landrace hemp house its farming territory of origin that correlates regenerative and energy saving, as well as locally inspired design strategies, there included the full valorisation of yield of GACP certified Cannabis, to identify its suitability as a building material or versatile resource.

 Propagation of locally inspired agro-industrial solutions for comfortable housing by inclusion of the indigenous farming society in the building process.



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LANDRACE YIELD % generating income (dry material, female plants) previous partially legalization resin valued seed previous 1.31 % legalization flowers & leaves stems 33.32 % 29.87 % potential new business sectors since 35.50 % Landrace legalization

Harvesting

METHODOLOGY DESIGN APPROACH

• Performance simulations using BIM technology (REVIT), GREEN BUILDING STUDIO and Autodesk INSIGHT for modelling, energetic configuation and generation of graphic results ANALYSIS

• **Determination of average yield per hectar of landrace components,** separating stems, seed, green materials and resin of materials collected at 4 different areas.

• Measure of stems lengths and sections.

TECHNOLOGIES

- Transformation of hemp stems with a decorticator prototype to obtain aggregates and fibres.
- Manual manufacture of 2000 Hemp-earth blocks sized 400 x 200 x 150 mm, using modified adobe technology.
- Elaboration and application of roof light concretes by mixing wet hemp fibers with dry sieved earth.

Simulation tools

• Formulation of earth mortars and plasters adding hemp fibres, hydrated lime and hemp seed oil.

Determination of landrace yield 2024 (%)



CANNATEKTUM habitat and materials science, S.L. (Spain); CEDRUS SATIVUS Sarl (Morocco)





AUTONOMY OF SPACE, NATURAL LIGHTING AND EXPOSURE TO SUNLIGHT





Etiologic architecture with Moroccan landrace hemp, restoring socio-cultural and agro-industrial scenarios Monika Brümmer, Architect PhD

CANNATEKTUM habitat and materials science, S.L. (Spain); CEDRUS SATIVUS Sarl (Morocco)

RESULTS (1)

The design has been organized meeting criteria of LEED for natural lighting, exposure to sunlight (under winter and summer conditions) and daylight autonomy.

Two cross ventilated areas have been created, one private and cooler, the other entering into dialogue with the panorama of the surrounding landscape.



Monika Brümmer, Architect PhD

CANNATEKTUM habitat and materials science, S.L. (Spain); CEDRUS SATIVUS Sarl (Morocco)



RESULTS(3) Landrace Hemp House "DAR AL KIF" int./ext. RH and T under Summer conditions 2024

"High and low relative humidity ranges increase the transmission and survival of virus and bacteria..." [Wolkoff, 2018]. Graphic image of RH health conditions: [Sterling et al., 1985].

ope

temp

(ºC)

21-23

23-25

(%)

40-50

45-60

RITE

winter

summer

	RITE
	winter
ENIVELODE COMPOSITION	summer
ofing membrane	



ler with 20 mm)

shives,



rative erature ºC)	relative humidity (%)	DAR AL KIF July 2024	operative temperature (ºC)	relative humidity (%)
-23	40-50	external	26,5-34	32-37
3-25	45-60	internal	22,4-24,6	52- <mark>62</mark>
rative erature	relative humidity	DAR AL KIF August	operative temperature	relative humidity





CONCLUSIONS

The landrace hemp house DAR AL KIF created a gateway to break down the barriers that prevent the inclusion of the rural population into the regenerative progress of their environment, into contemporary comfort conditions and into economic growth, valorising on the full resource of GACP certified Cannabis without creating agricultural waste. We have seen that the proposed energetic configuration with modern design tools in combination with the physical properties of landrace agro-resources is a energy-efficient option to build or restore houses in the upper Central Rif. This practice avoids the import of materials into remote African regions and the burning of more than 2 tons of dry stems per hectar, so that the CO2 metabolized by the plants is not released into the atmosphere, but retained in the building envelope. The proposed solution allows the rural population to improve their performance through healthy living and protects their water retaining cedar forest due to a low operative energy consumption.



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CEDRUS SATIVUS Sarl, Issaguen/Al Hoceima, Morocco

Data Transparency Challenges in the Hemp Sector: Implications for Product Development and Market Access

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Abstract:

In a rapidly evolving market landscape, new product development is a vital strategy for companies aiming to stay competitive, innovate, and meet changing consumer demands, especially within the biobased industry. The availability and cost of raw materials significantly influence production capacity, market supply, and product pricing, making transparent data essential for strategic planning and product innovation. While the cotton market sets an exemplary standard for data transparency - offering comprehensive figures on cultivation areas, prices, and market conditions - the hemp industry faces substantial challenges. This presentation explores data availability in the European hemp sector, focusing on the discrepancies in reported cultivation figures over recent years. Even among reputable sources, considerable inconsistencies in data are observed, creating a fragmented picture of the market. The difficulty in obtaining reliable information extends further, as figures on fibre and shives quantities across specific market segments are largely unavailable. This lack of transparency poses a significant challenge for companies and investors who struggle to navigate and make informed decisions in an unclear market environment. Preliminary investigations conducted by the authors reveal that this opaque market situation acts as a barrier for firms and funding institutions considering investment in the hemp sector. The absence of a reliable and comprehensive market study since the nova-Institute's report over a decade ago underscores the need for a new, updated analysis. To address this gap, the authors have initiated a new market study to gather and provide reliable data to serve as a foundation for industry development and growth. In this presentation, the authors will discuss the challenges and risks associated with the current data landscape in the hemp industry. By comparing the situation to the cotton market's approach to data transparency, the presentation will illustrate the potential benefits of having precise, accessible figures on cultivation, yield, and pricing. Furthermore, the authors will present the methodology and objectives of their upcoming market study, designed to create a more transparent, data-driven framework for companies, investors, and stakeholders in the hemp industry. This presentation aims to highlight the importance of data transparency as a catalyst for innovation, market access, and sustainable development in the hemp sector. By improving data availability and reliability, the industry can foster a conducive environment for investment, strategic planning, and the successful introduction of new hempbased products.

Data Transparency Challenges in the Hemp Sector: Implications for Product Development and Market Access

Müssig, J.¹, Baumann, J.¹, Partanen, A.², Carus, M.², Blank, H.³ & Kölzig, K.³







WHAT positive examples exist in natural fibres ?

Production

to the suppry, ore						Oct
Season Beginning August 1	2020/21	2021/22	2022/23	2023/24	2024/25	2024/25
PRODUCTION						
China	6,379	5,813	6,695	5,955	6,053	6,140
India	5,987	5,291	5,726	5,617	5,225	5,225
Brazil	3,000	2,356	2,552	3,172	3,636	3,658
United States	3,181	3,815	3,150	2,627	3,160	3,092
Pakistan	980	1,306	849	1,524	1,241	1,241
Australia	610	1,274	1,263	1,089	1,089	1,089
Türkiye	631	827	1,067	697	871	871
Other	3,995	4,214	4,055	4,066	4,073	4,080
Total	24,763	24,896	25,357	24,747	25,348	25,395

BREMEN COTTON REPORT

Müssig et al. / 2024-11-19 / Data Transparency Challenges in the Hemp Sector ...

The Biological Materials Group 🛚 💃 HS

World Hemp Forum ... Troyes Müs

WHY is there such a confusion in hemp data 2













Research to Support the Hemp Industry

David R. Gang

Director, Center for Cannabis Policy, Research and Outreach Professor, Institute of Biological Chemistry Washington State University gangd@wsu.edu







Sustainably Incorporating Hemp Biobased Economy into Western U.S. Regional Rural and Tribal Lands



Two large USDA-NIFA SAS Grants

Partnerships with:

Oregon State University, UC Davis and Univ. of Nevada Reno, Tribal Nations

Building a foundation for a vibrant hemp industry in the Western USA.

Industrial hemp grown for 4 "F"s:

- Fiber
- Food
- Fuel
- "Farmacy"





I INIVERSITY

WASHINGTON STATE

Hemp Value Chain Development, Production, and Utilization





orld Class. Face to Face. 👘

I INIVERSITY

A.









USDA-SAC Diversity Trials – Rebuilding the NPGS Hemp Collection







Varieties Vary Widely in Composition: Seed Lipids





Institute of Biological Chemistry

WASHINGTON STATE

DOE Project – Biochar and Hemp in Crop Rotations





A.

J JNIVERSITY

Institute of Biological Chemistry

Areas of study and field trials







Life Cycle Assessment System Boundary – Attechatiant Scemanics (Bisehae)) Functional unit: 1 tonne of hemp

System Boundary: "Cradle-to-Gate"



LCME

Institute of Biological Chemistry

Questions?

David Gang gangd@wsu.edu







Mycelium based materials for thermal insulation



Hyphos Le vivant au service du futur



Presentation of the laboratory

innovatielab

Main research subject of the innovatielab :

- Biobased composite materials including mycelium materials
- Solar boat
- Smart farming
- Care robot



General challenge of thermal insulation market :

Important need of thermal insulation : 70% of accomodations in France have an energy label inferior or equal to D

Need of environmental friendly solution : Only 2% of external insulation is biobased

Need of high performance : current biobased solutions have lower performance


Product life cycle







The study at Inholland

Main question : How can thermal conductivity of insulating mycelium-based panel for building be improved by adding air cavities inside of it ?

Sub question:

- Characterize of the material (Conductivity, mechanical behavior)
- Find the best cavity shape and pattern
- Study the influence of the cavities on the conductivity
- Optimise conductivity and mechanical requirement
- Research manufacturing solutions

The study at Inholland

Main results :

- Conductivity of Hemp/mycelium based materials :
 - Regular production method : 45 mW/K / 100kg/m3
 - Improved production method : 42,5 mW/K.m / 80kg/m3
- Mechanical performance Hemp/mycelium based materials :
 - Young's modulus of 2,88 MPa (at 2% strain)
 - maximum tensile stress at 0.092 MPa.

Conclusion of the study:

- Promising theorical results
- Necessity to improve processes of fabrication (repeatability & insertion of cavities)
- Many challenges before industrialization



What's next ?

Research continue

- Innovatie Lab develops production line for mycomaterials in open source
- ESTP (Troyes) :
 - 15 students working with mycelium to improve comfort in building
 - Recruitment of 1 student to explore 3D mycelium printing

Hyphos :

- Incubation's Jury around 10th December
- Goals : production of the first packaging in March
- Require 15 000 € to start in January

Le projet Hyphos c'est déjà..



THESE THE COLORI

CUNICIONAL

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UNIVERSITE DE TECHNOLOGIE



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UNIVERSITE DE REIMS **CHAMPAGNE-ARDENNE**

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Van



CONSTRUCTEURS D'UN NOUVEAU MOND





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