



BECCOOL

Brazil-EU Cooperation for Development
of Advanced Lignocellulosic Biofuels

RESULTS OF INNOVATIVE CROPPING SCHEMES FOR INTEGRATED FOOD-AND- BIOMASS CROPS

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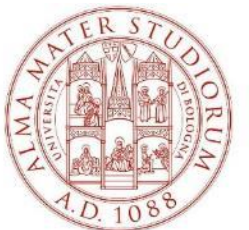
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ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

BECOOOL PROJECT AT GLANCE



- **Project title:** Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels
- **Coordinator:** University of Bologna (Prof. Andrea Monti)
- **12 Partners**
- **General objective:** Strengthen the EU-Brazil cooperation on advanced lignocellulosic biofuels
- **Twin Brazilian Project:** BioValue (20 Partners)
- **Project duration:** 2017-2022

BECOOOL kick off meeting in Bologna

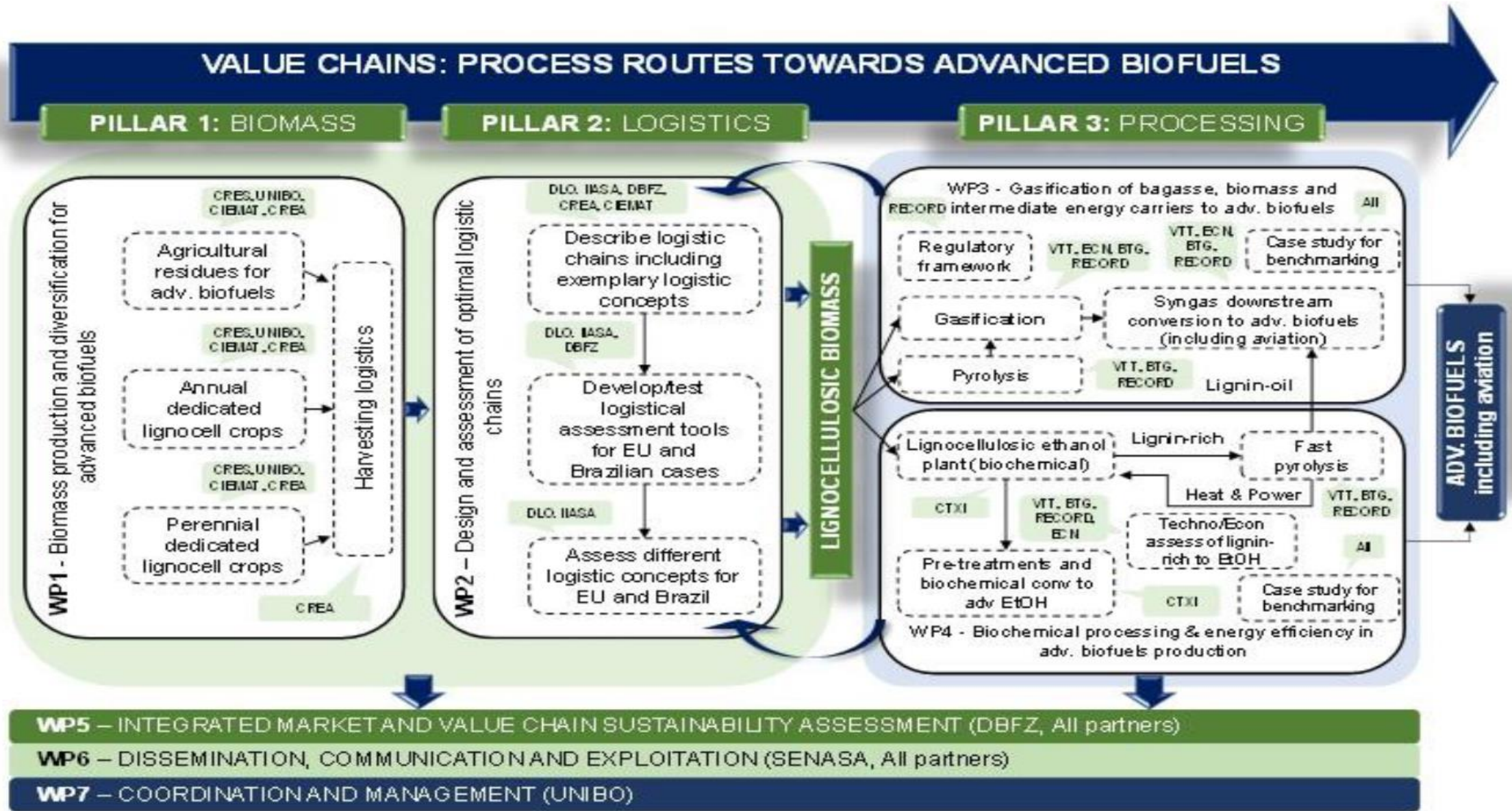


**Kick off:
Brazilian coordinators and governatives
joined the meeting**



**December 2019
Technical meeting in Recife
(Br)**

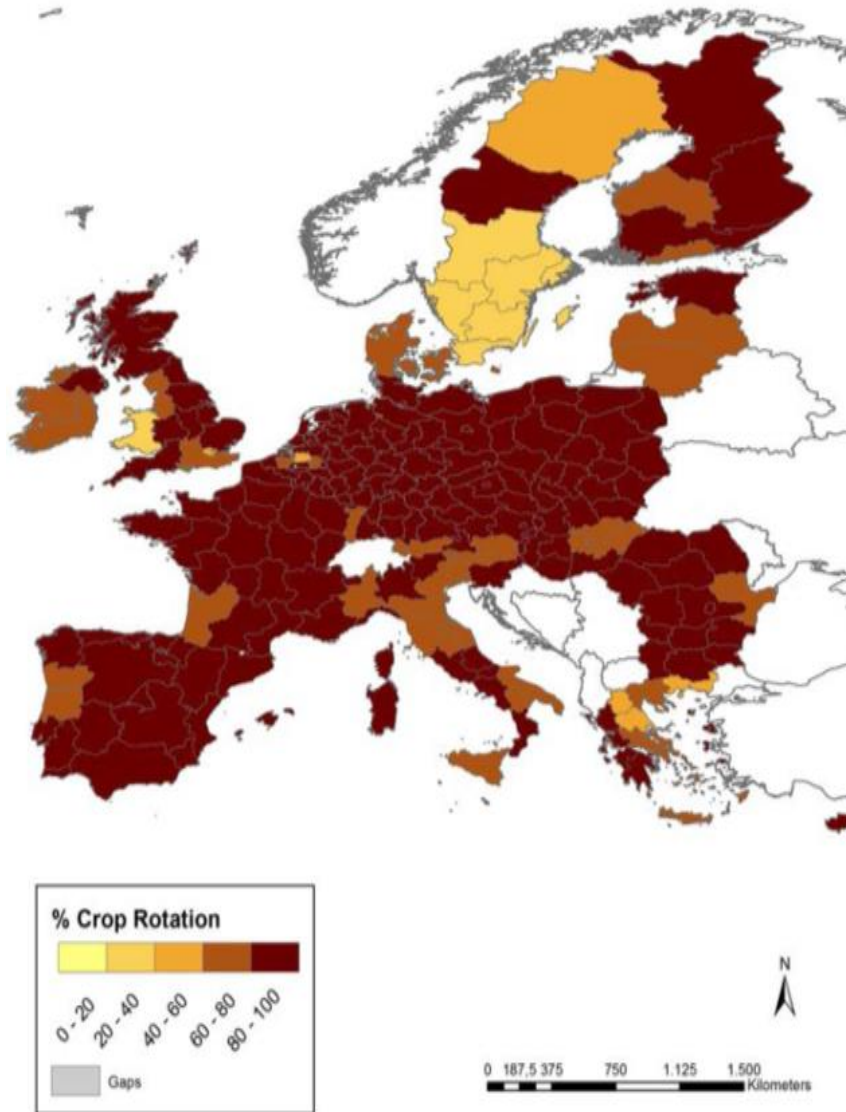
Synergistic/complementary activities between BioVAULE and BECOOL



General objective of WP1: to increase lignocellulosic biomass production and feedstock diversification without reducing food crop land.

How to reach this target???

=> Identifying integrated cropping systems including lignocellulosic and food crops

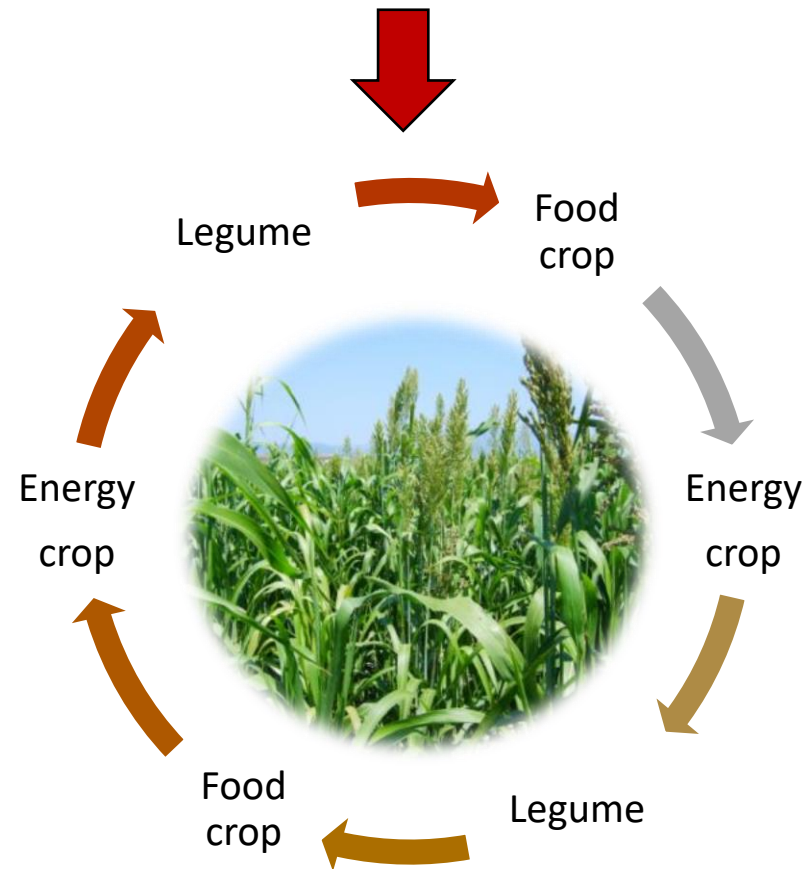


State of the art:

2/3 of arable land in EU-28 is dominated by conventional crop rotations based on only two main food species (e.g. wheat-maize rotation)

New cropping schemes: the concept

The today cropping systems could be intensified and diversified including lignocellulosic crops



Potential advantages of innovative cropping systems

1. Enhanced **soil fertility** due to positive rotational effects
2. reduced **soil erosion** due to a longer land cover
3. sustainable cropping systems due to **low inputs** requirements (agrochemicals, fertilizers etc.)
4. **market opportunities** and **reduced** economic **risks** for farmers
5. Production of feedstock **without competing** with food land

Challenges of the innovative cropping systems

1. Identify the crops
2. New farming systems and machineries
3. Innovative logistic concepts
4. Sometime unfamiliar crops for farmers

Challenges of the innovative cropping systems

- The performance of new crops is quantitatively and qualitatively evaluated (e.g. sunn hemp, fibre sorghum, kenaf and industrial hemp)
- Field studies are replicated in Italy, Greece and Spain



New cropping systems at the experimental farm of the University of Bologna

Challenges of the innovative cropping systems

The integrated cropping systems including food and lignocellulosic crops are:

C: maize – wheat – fallow – maize (control rotation)

R1: maize – sunn hemp+ wheat – sunn hemp – maize


R2: maize – biomass sorghum+ wheat – sunn hemp – maize

R3: maize – kenaf+ wheat – sunn hemp – maize

R4: maize – hemp+ wheat – sunn hemp – maize

R5: sunn hemp + wheat – sunn hemp+ wheat

green: food crop
orange: legume
blue: energy crop



	2017					2018					2019					2020					2021					2022												
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
C	Maize					Wheat					Maize					Wheat																						
R1	Maize					Sunn Hemp					Wheat					Sunn Hemp					Maize					Sunn Hemp				Wheat								
R2	Maize					Fiber sorghum					Wheat					Sunn Hemp					Maize					Fiber sorghum				Wheat								
R3	Maize					Kenaf					Wheat					Sunn Hemp					Maize					Kenaf				Wheat								
R4	Maize					Hemp					Wheat					Sunn Hemp					Maize					Hemp				Wheat								
R5	Sunn Hemp					Wheat					Sunn Hemp					Wheat					Sunn Hemp					Wheat					Sunn Hemp				Wheat			

RCBD with 4 reps

Example of new crop: sunn hemp (*Crotalaria juncea* L.)

- A tropical Asian legume crop (Fabaceae).
- Widely grown throughout the tropics and subtropics as a source of **green manure**, **fodder** and lignified **fiber**
- Possible source of protein (37% content in seeds)

Sunn hemp in rotation system:

Advantages:

- Resistance to root-knot nematodes
- Through biological N₂ fixation, it can improve soil fertility and the yields of succeeding food crops
- Low input requirements

Disadvantages:

- New to EU environments
- Limited information available on the rotational effect of sunn hemp



Energy crops harvest in Italy (August – September 2018)

Hemp harvesting with mowers



Kenaf harvesting with shredder



Sorghum harvesting with shredder



Field drying



Baling



Weighing



Wheat succeeding energy crops

Quick seedbed preparation
November 2018



Sowing
November 2018



Wheat emergence
December 2018



Wheat elongation
April 2019



Wheat fully ripe
June 2019



Harvesting
July 2019



Weighing
July 2019



Sunn hemp succeeding wheat

Quick seedbed preparation
July 2019



Sowing
July 2019



Sunn hemp emergence
July 2019



Sunn hemp harvesting
October 2019



Windrowing
October 2019



Baling
October 2019



Subsoiling
October 2019



Preliminary conclusions from the italian rotations

- **Wheat grain** production following the energy crops was **not affected**
- The preliminary results indicates that the tested systems are promising and that dedicated **energy crop** can **coexist** with **food crops**
- **Biomass sorghum** seems to be the **highest yielding** crop but it was affected by **lodging** that hampered the mechanical harvest
- **Industrial hemp** and **sun hemp mechanical harvesting** should be improved even though the yields were satisfactory
- **High kenaf humidity** at harvest and **low yield**
- Further evaluation are ongoing (soil and biomass qualitative analysis)

Thanks for your attention



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