Highlights from case studies on marginal lands

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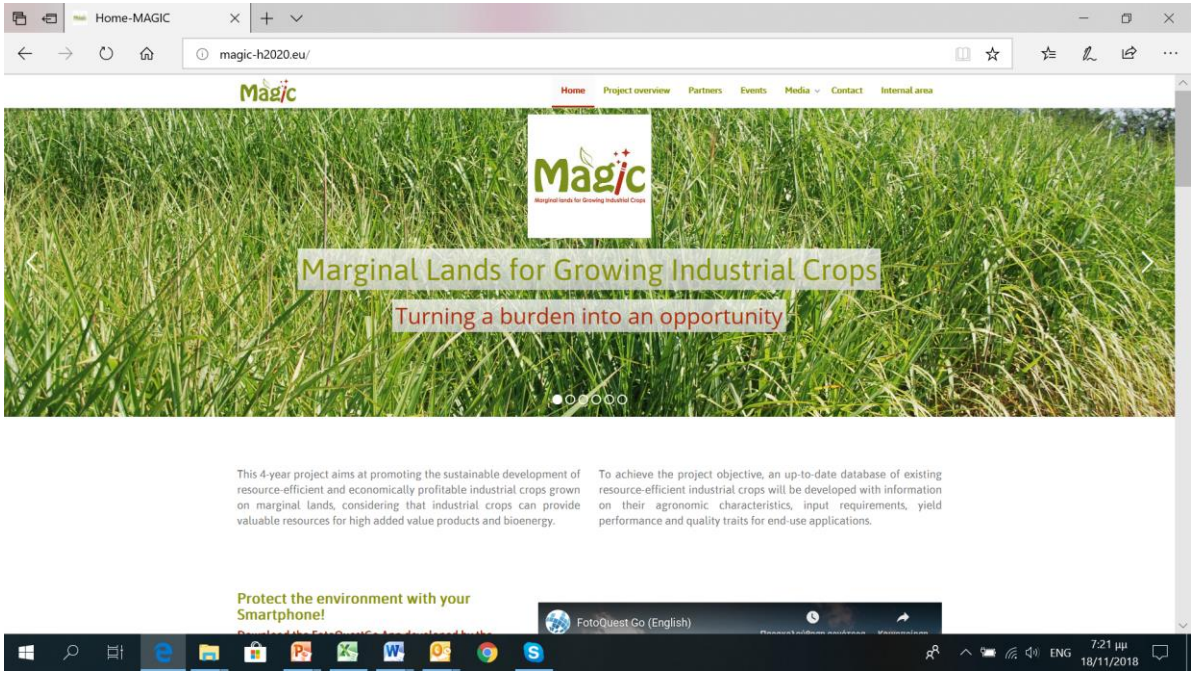


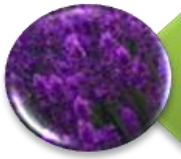
MAGIC aims to promote the sustainable cultivation of industrial crops on marginal lands

INDUSTRIAL CROPS
primarily grown for industrial applications rather than food and feed uses

Oil crops
(crambe, camelina, castor, safflower, rapeseed, sunflower, tobacco,etc.)

Lignocellulosics crops
(perennial crops/grasses, fiber crops, woody species)

Carbohydrate crops
(sweet sorghum, sugarbeet, corn, cassava, potato, etc.)



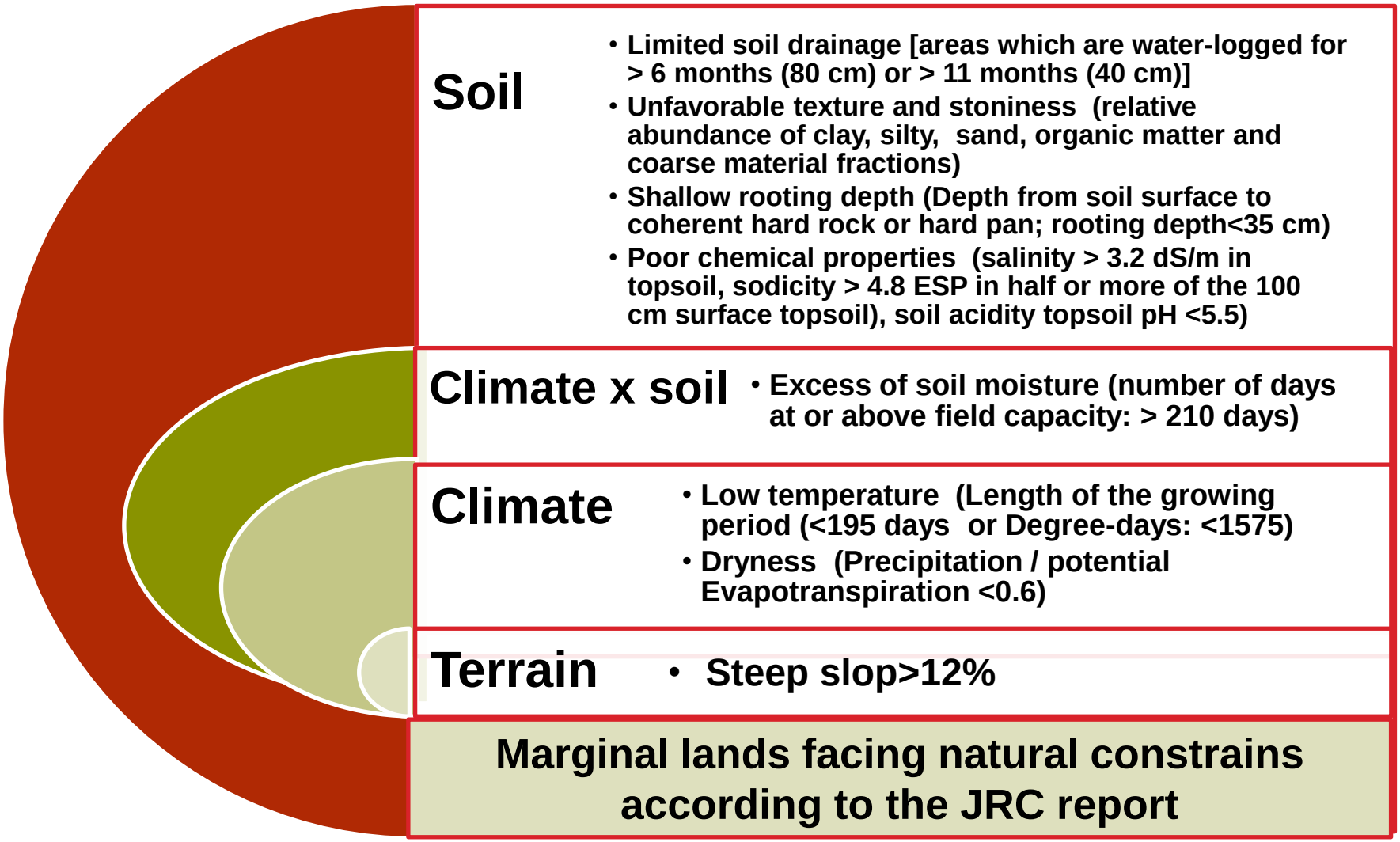
Speciality crops
(calenduala, lavender, peppermint, coneflower, ribwort plantain, etc.)

On MARGINAL LANDS for:

- Increased and resource-efficent feedstock with low ILUC for biobased economy
- Diversified and increased farmers' income

MAGIC is working on marginal lands facing natural constraints according to JRC report, which categorizes the marginal lands on criteria based on climate (low and high temperatures, dryness, wet soils, etc.), soil (unfavorable soil texture, rooting depth, etc.) and terrain (slope). In MAGIC contaminated lands have been also included.

Although MAGIC is mainly working on marginal lands facing natural constraints contaminated lands are also included



Why to grow industrial crops on marginal lands?

Industrial crops contribute: a) to the diversification of farmers' income and b) to the supply of renewable raw materials

Industrial crops to be grown on marginal land (~1,350,000 ha in Europe) to avoid food vs fuel competition

Added value of the end-uses applications

Fine or bulk chemicals

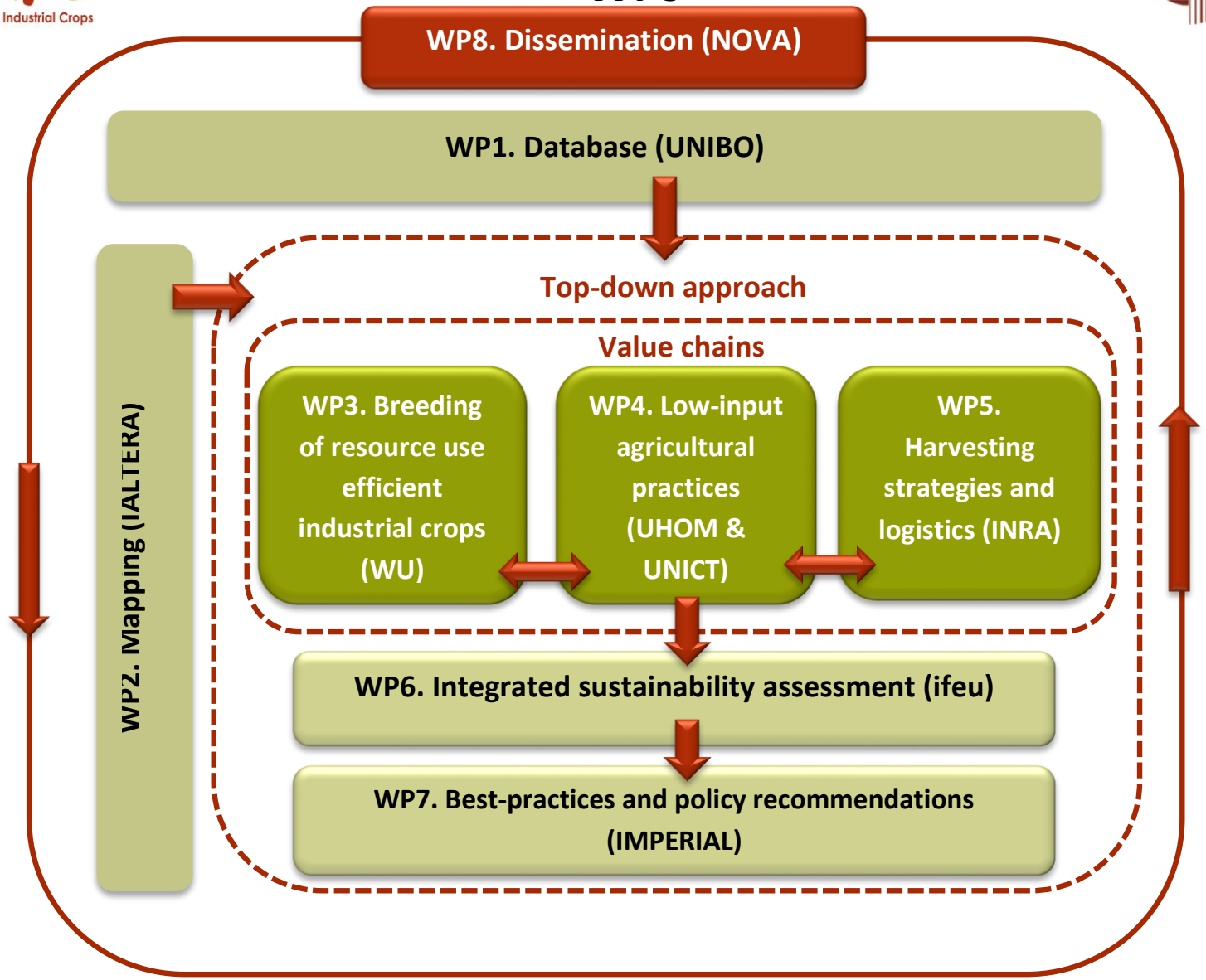
Biomaterials

Bioenergy

Industrial applications fostering the biobased economy

Climate change mitigation

Methodology & schematic view of the WPs



Main idea, how it will be accoplished and what will be developed

MAGIC idea

- to exploit the marginal land for the cultivation of industrial crops with low ILUC offering resource-efficient crops/varieties for industrial applications

How will it be accomplished?

- Selection of most appropriate industrial crops for Europe (WP1)
- Mapping of the marginal land (WP2)
- Breeding strategies for resource-efficient crops/varieties and improvement of low-input agronomic practices (WP3, 4)

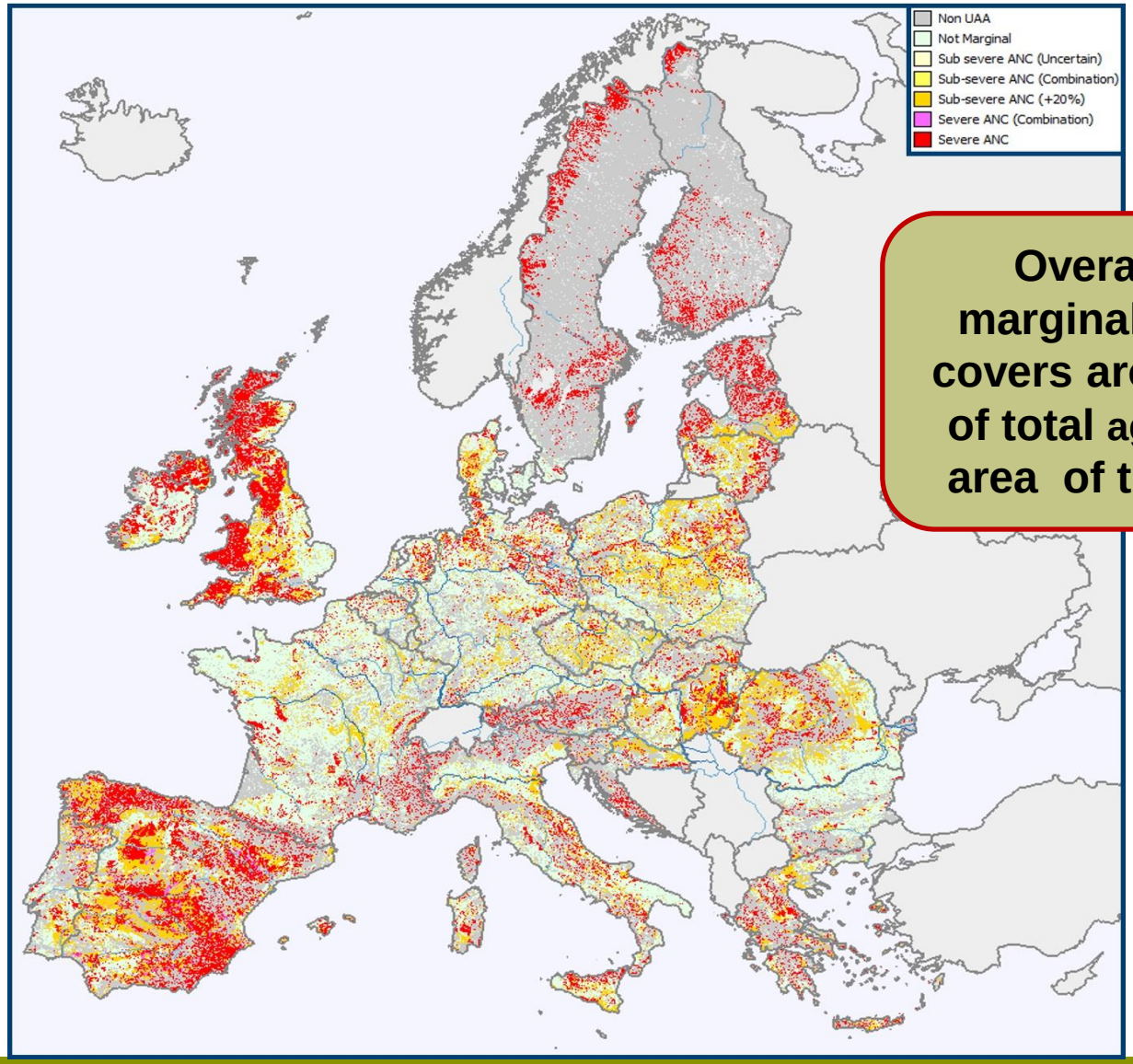
The farmers' awareness will be increased through project tools (database, DSS & maps) and events (workshops & training). Strong link with EIP AGRI

A multi-actor approach will be adopted engaging scientists, farmers' cooperatives, industry NGOs and SMEs.

Additionally, MAGIC will develop:

- User-friendly Industrial crops databases (MAGIC-CROPS & MAGIC-MAPS) and a DSS tool (MAGIC-DSS) for end-uses (WP1)
- Sustainable supply chains for industrial products (WP5 & WP6)
- Best-practice guidelines and policy recommendations (WP7)

Marginal lands based on biophysical constraints in EU-28 (marginal lands are in the severe and sub-severe class) taken from Elbersen et al. (2018b).



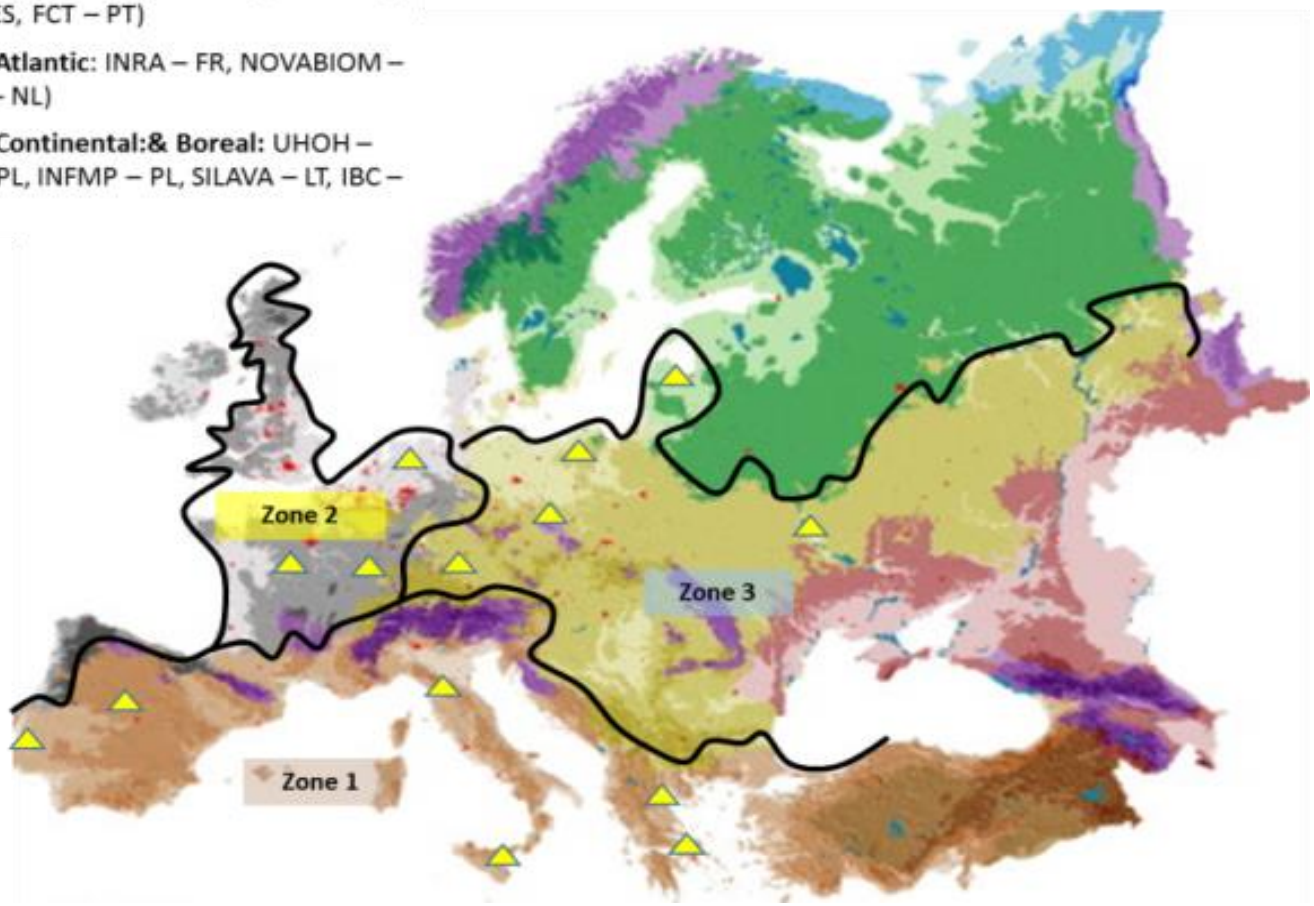
Overall, the marginal surface covers around 28% of total agricultural area of the EU-28

Major geographical/climatic zones in Europe; yellow spots indicate new and established field trials

Zone 1 - Mediterranean north and south: CRES – GR, AUA – GR, UNICT-IT, UNIBO-IT, CIEMAT-ES, FCT – PT)

Zone 2 - Atlantic: INRA – FR, NOVABIOM – FR, DLO – NL)

Zone 3 - Continental:& Boreal: UHOH – DE, 3B – PL, INFMP – PL, SILAVA – LT, IBC – UKR)



Already established trials on perennial crops: all WP4 partners

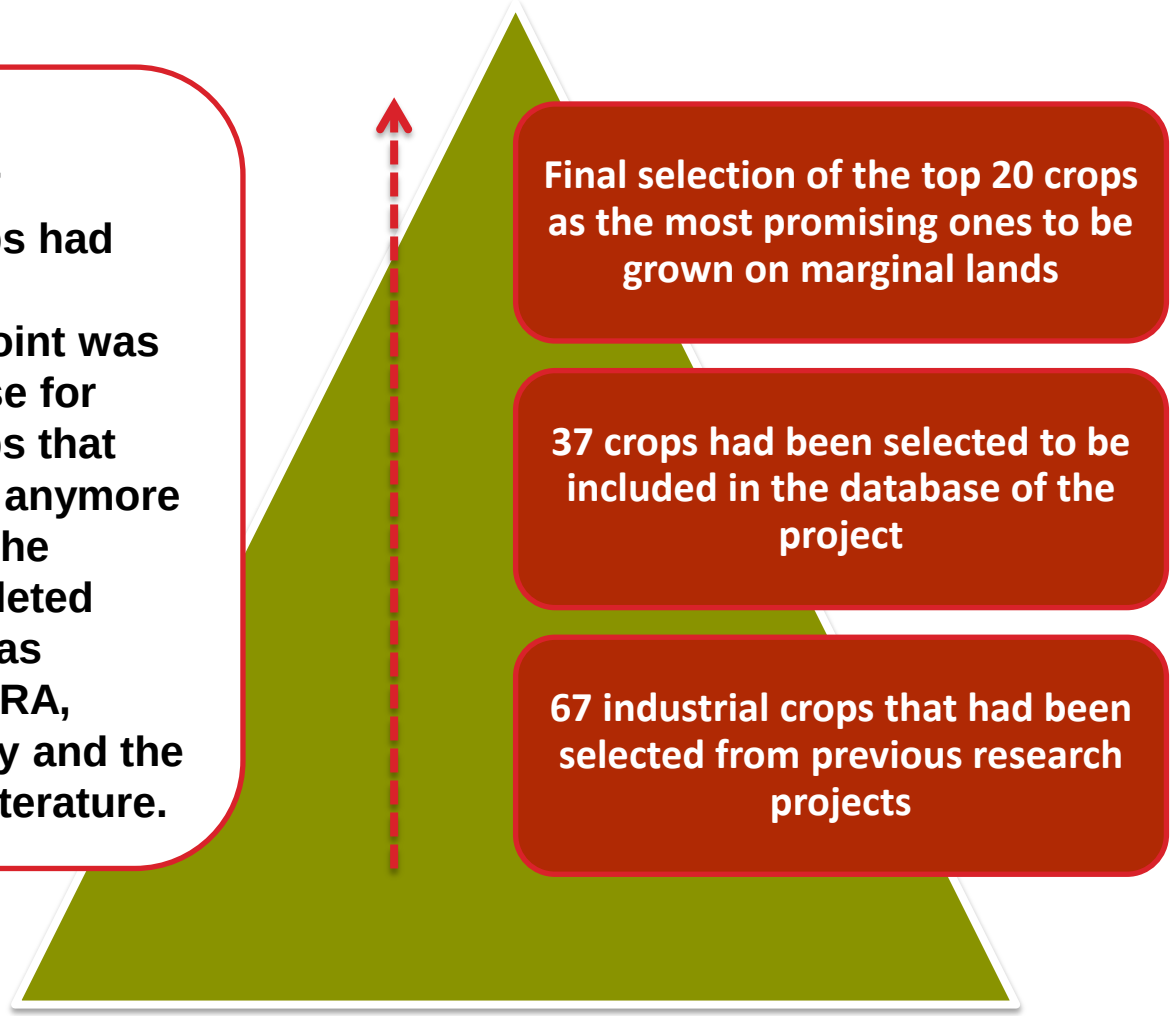
Small-scale field trials on top 15 industrial crops under different marginality factors: CRES, UNICT, CIEMAT, INRA, UHOH, SILAVA, IBC

Large-scale field trials on top 15 industrial harvesting trials and realistic data for WP5 & 6: CRES, UNIBO, CIEMAT, NOVABIOM, UHOH, SILAVA, IBC

Pot trials: AUA, UNICT, FCT UNL, INFMP

Selection of the most promising industrial crops to be grown on marginal lands

- How the initial selection of 67 industrial crops had been done?
- The starting point was an old database for industrial crops that does not exist anymore (like IENICA), the recently completed projects such as 4FCROPS, FIBRA, Crops2Industry and the international literature.



Most promising industrial crops for MAGIC

Oilseed and specialty crops
camelina, crambe, castor bean, Ethiopian mustard, safflower, lupin, hemp, cardoon, pennycress

Lignocellulosic crops
[perennial crops/grasses, fiber crops (bast, leaf and/or hair ones), woody species]

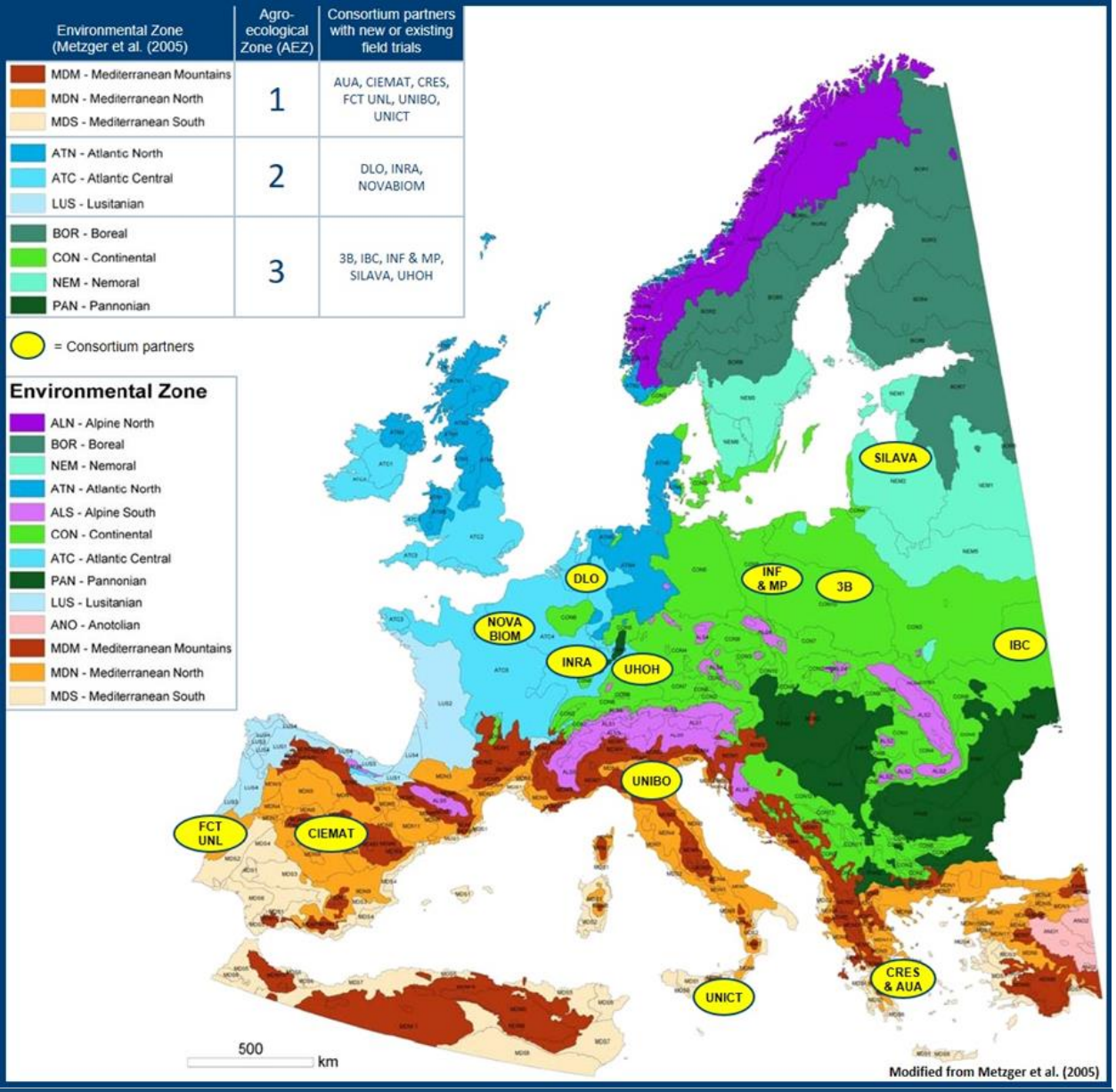
Carbohydrate crops
sweet sorghum, lupin

Perennial herbaceous
switchgrass, miscanthus, giant reed, reed canary grass, cardoon, tall wheatgrass, wild sugarcane

Fibre crops
industrial hemp, fiber sorghum

Woody crops
willow, poplar, Siberian Elm, black locust

- **20 industrial crops** have been selected in total
- **8** of them can be grown in all partners of the project (**camelina, crambe, switchgrass, miscanthus, industrial hemp, pennycress, poplar, Siberian elm**)
- Some of them can be grouped in more than one category (such as cardoon, hemp, etc.).



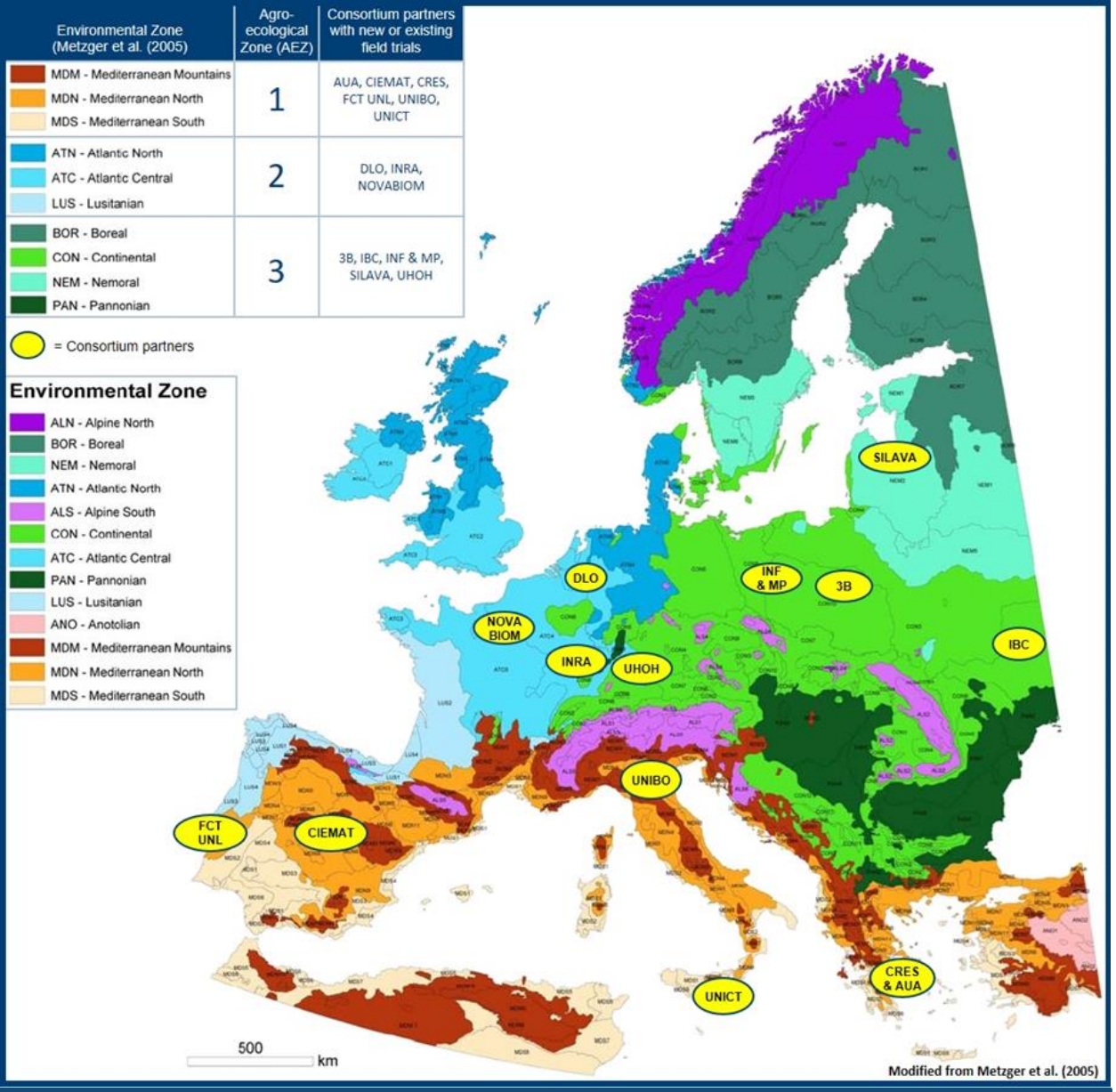
Distribution of agro-ecological zones taken into consideration for the development of marginal land low-input systems for industrial crops across Europe modified from Elbersen et al. (2018a) and Metzger et al. (2005)

Selected Industrial crops

Camelina*

1. Crambe*
2. Castor bean
3. Ethiopian Mustard
4. Safflower
5. Pennycress*
6. Switchgrass*
7. Miscanthus*
8. Giant reed
9. Reed canary grass
10. Cardoon
11. Tall wheatgrass
12. Wild sugarcane
13. Poplar
14. Willow
15. Black locust*
16. Siberian Elm*
17. Industrial hemp*
18. Fiber/sweet sorghum
19. Lupin

*These crops can be cultivated in all Europe.



Distribution of agro-ecological zones taken into consideration for the development of marginal land low-input systems for industrial crops across Europe modified from Elbersen et al. (2018a) and Metzger et al. (2005)

КАПЕ CRES

Long-term field trials on marginal lands

1. CRES (switchgrass, giant reed, miscanthus & cardoon)
2. UNICT (miscanthus, giant reed, wild sugarcane)
3. UNIBO (giant reed, miscanthus)
4. CIEMAT (switchgrass, tall wheat grass, Siberian Elm)
5. FCT UNL (miscanthus, giant reed)
6. NOVA & NOVABIOM (miscanthus)
7. WR (switchgrass, miscanthus)
8. UHOH (miscanthus)
9. 3B (willow)
10. SILAVA (willow, poplar)
11. IBC (switchgrass, willow)

Miscanthus (*Miscanthus x giganteus*)
Poaceae family

It has been selected by OPTIMA (www.optima.fp7.eu) and OPTIMISC (https://optimisc.uni-hohenheim.de/en)) projects as a promising crop to be grown on marginal lands. Currently, has been included in GRACE project (www.grace-bbi.eu) to be grown on marginal and/or contaminated lands.

In MAGIC it has been tested on long-term field trials established under dryness, unfavorable soil texture (shallow soil depth, acidity, heavy clay soils), contaminated lands and marginal lands for socio-economic reasons.

The long-term field trials for miscanthus have been established in Greece, Italy, Portugal, France, Netherlands, Germany with lifetime 2 to 14 years. New field trials have been also established in the view of MAGIC project in France and Germany.

Switchgrass (*Panicum virgatum* L.)
Poaceae family

It has been selected by OPTIMA project (www.optimafp7.eu) as a promising crop to be grown on marginal lands. Large variety of cultivars and thus can be successfully been cultivated in all Europe. Long-term trials in Europe have been proved mean dry matter yields of 10t/ha on marginal lands.

In MAGIC long-term switchgrass field trials have been established under dryness, unfavorable soil texture (shallow soil depth, heavy clay soils) and marginal lands for socio-economic reasons.

The long-term field trials for switchgrass have been established in Greece, Italy, Netherlands and Ukraine with lifetime 2 to 20 years. New field trials have also been established in MAGIC.

Giant reed (*Arundo donax* L.)
Poaceae family

It has been selected by OPTIMA project (www.optimafp7.eu) as a promising crop to be grown on marginal lands in South Europe. Before that it had been investigated in Bioenergy Chains project (www.cres.gr/bioenergy_chains) on marginal lands. Long-term trials in Greece on marginal lands proved mean yields of 15 t/ha for a period of 15 years.

In MAGIC it has been tested on long-term field trials established under dryness, unfavorable soil texture (shallow soil depth, acidity, heavy clay soils), contaminated lands and marginal lands for socio-economic reasons.

The long-term field trials of giant reed have been established in Greece, Italy and Portugal with lifetime 6 to 16 years. New field trials have been also established in the view of MAGIC project in Italy.

Willow (*Salix* spp.)
Salicaceae family

Grows in a variety of soils with pH 5-7.5. Its roots stand highly anoxic conditions and thus can be planted in waterlogged conditions. Due to its high tolerance to soils with heavy metals it can be used for phytoremediation.

In MAGIC it has been tested on long-term field trials established under a) with excess soil moisture and b) unfavorable soil texture

The long-term field trials of willow have been established in Poland, Ukraine and Latvia with lifetime 5 to 13 years. New field trials have been also established in 2017 and 2018 in Latvia and Ukraine on marginal lands with unfavorable texture & stoniness soil (clay).

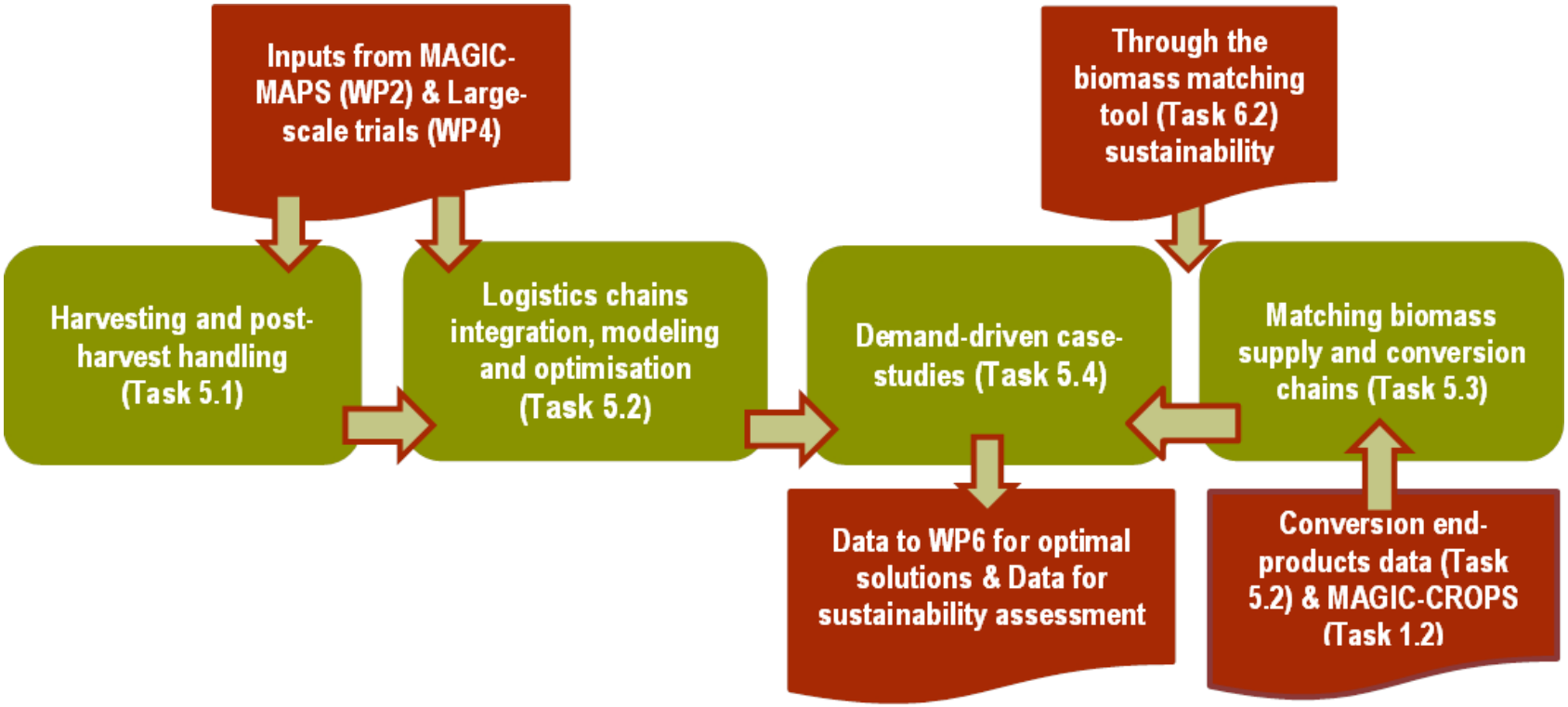
Poplar (*Populus* spp.)
Salicaceae family

In multibiopro project (www.multibiopro.eu) poplar had been selected as non-food crop that can be grown on marginal lands. Currently, poplar has been selected by Dendromass4Europe project (www.dendromass4europe.eu) mainly due its tolerance to a wide range of soil conditions .

In MAGIC it has been tested on long-term trials established in fields: a) with excess soil moisture and b) unfavorable soil texture

The long-term field trials have been established in Poland and Latvia and currently have lifetime varied from 5 to 7 years. New field trials have been also established in 2017 & 2017 in Latvia on marginal lands with unfavorable texture & stoniness soil (clay).

Biomass supply chains in MAGIC



The steps that will be followed are:

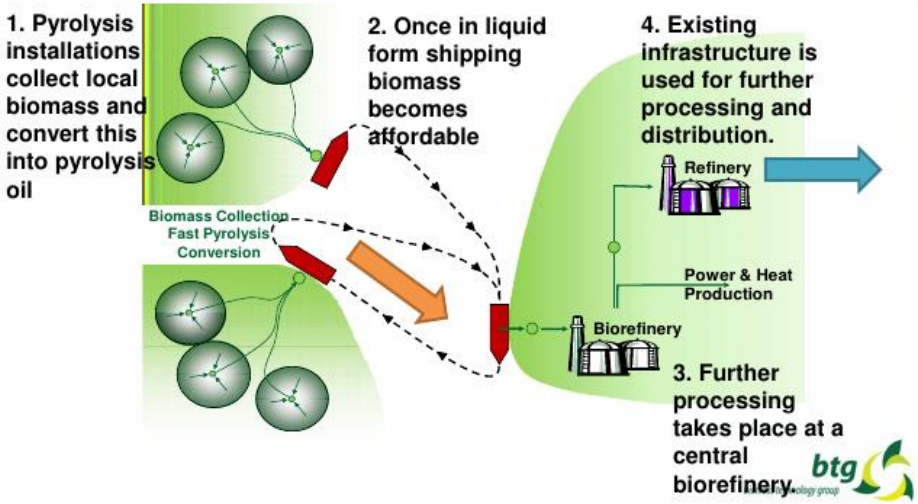
- **To design new harvesting and logistics systems or technologies tailored to the characteristics of industrial crops grown on marginal land (Task 5.1)**
- **To select the existing technological pathways with the highest overall efficiency along the whole supply chains, as driven by the needs of the targeted conversion process (Task 5.2)**
- **To match the biomass supply with the conversion chains (Task 5.3)**
- **To carry out demand-driven case studies (Task 5.4)**

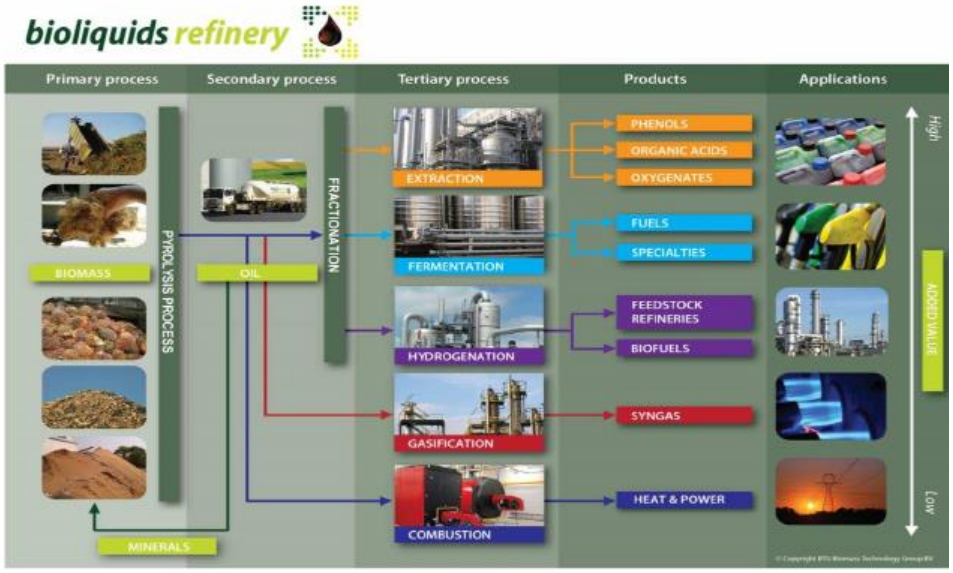
Match industrial with conversion technologies

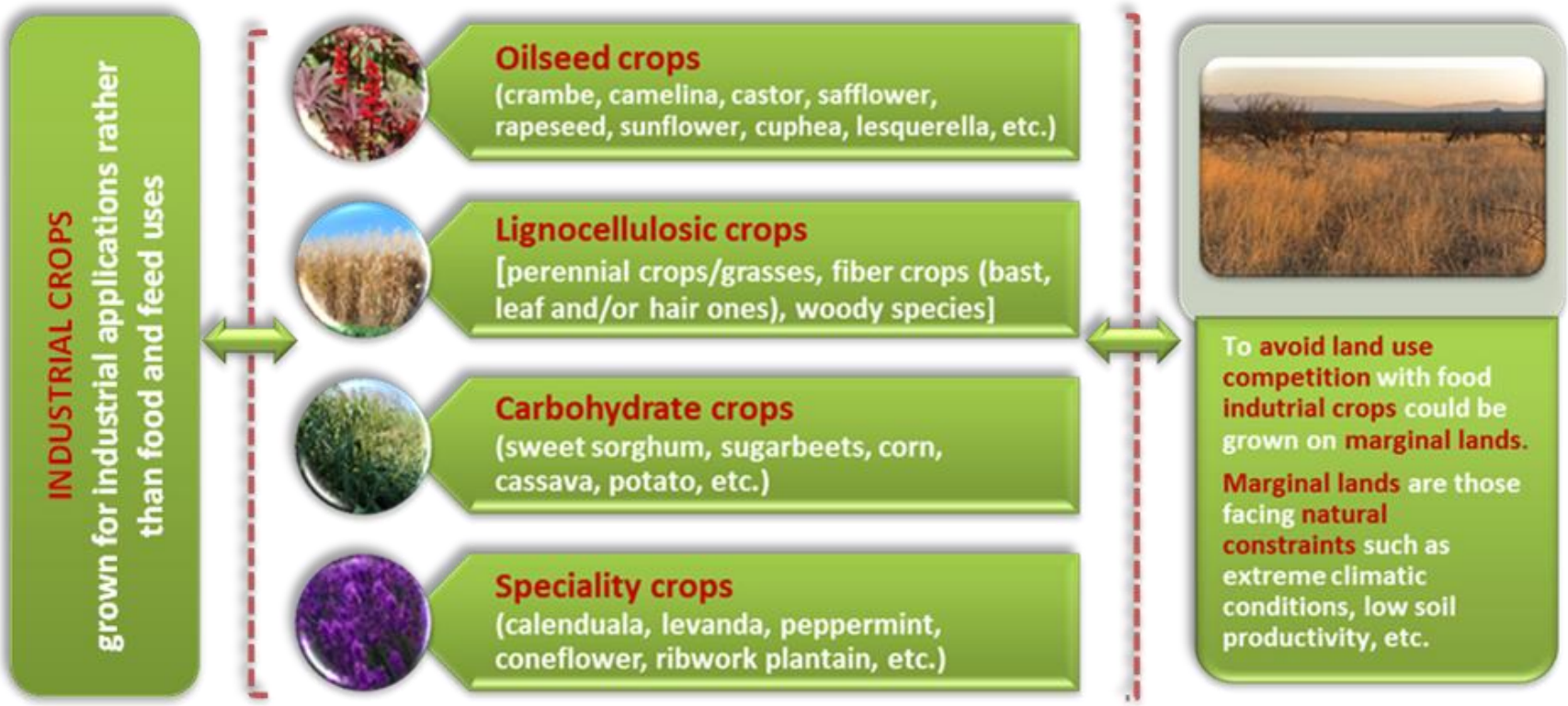
Lignocellulosic crops	S2BIOM	Lignocellulosic technologies
Carbohydrate crops Oil crops Fiber crops Specialty crops	MAGIC	Carbohydrate technologies Oil crops technologies Fiber crops technologies Specialty crops technologies

Demand-driven case studies

Name	Conversion pathway / end-product	Industrial crop and cultivation site
Arkema	Biopolymers	Castor to take seed oil; Bulgaria and/or Romania
Empyro #1	Pyrolysis oil	Miscanthus and/or other perennial grasses; grown in France
Empyro #1	Pyrolysis oil	Lignocellulosic crops (to be decided by M18); grown in Spain







Thank you for your attention

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