Marginal lands for Growing Industrial Crops

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D1.3: List with the selected most promising industrial crops for marginal lands

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DEM	Demonstrator, pilot, prototype	☐	**CO**	Confidential, only for members of the consortium (including the Commission Services)	☐
DEC	Websites, patent fillings, videos, etc.	☐			
OTHER		☐			

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Publishable executive summary

The aim of **D1.3** was to present the list with the **most promising industrial crops** to be grown on **marginal lands facing natural constraints**. The work started from a total number of **67 selected industrial crops** (old databases and/or projects) that was presented and discussed in the 2nd technical meeting of the project (27th and 28th of November 2017). In the same meeting it was selected the list of **industrial crops that will be included in the MAGIC-CROPS database** (38 crops) as well as **the list of the crops that will be included in the multi-criteria analysis of task 1.3** in order **the most promising industrial crops for MAGIC project** to be selected**.**

The **selection criteria in DoA** of the project were: a) maturity of knowledge on industrial crops on marginal land, b) crop performance for bio-based products, c) crops' productivity on marginal land, d) TRL of mechanical cultivation, e) crop adaptability under specific combinations of natural constrains in each M-AEZ, f) industry needs and g) market opportunities. In the 2nd technical meeting the criteria had been modified and the final criteria set were: a) experience with agricultural management of the proposed industrial crops, b) crop productivity for industrial applications (according to the main uses), c) expected crop performance on marginal land, d) industry needs and market opportunities. Each criterion had to be marked in a scale 1 to 5. It has been decided the weight of the final selected criteria not to be the same and to be as follows; 20% for the first two, 30% for the third and 15% for the last two. In the figure below (Figure 1) is presented the steps that had been followed for selection of the most promising industrial crops (D1.3).

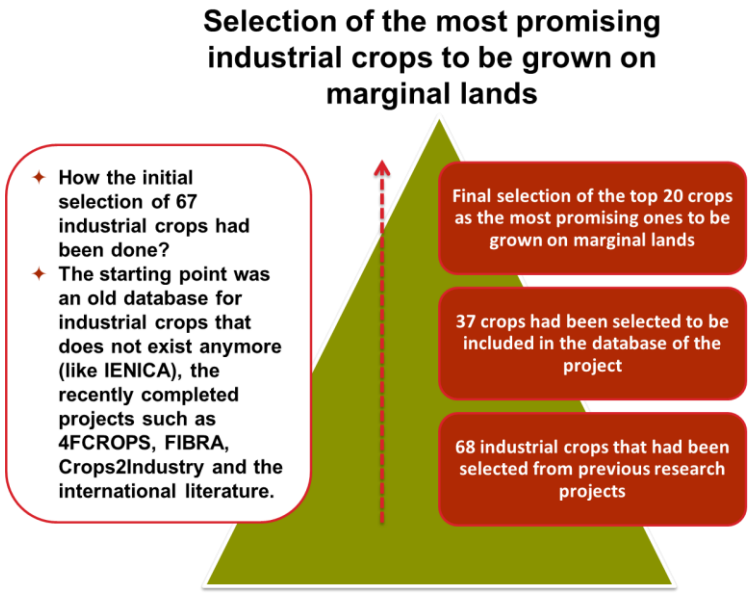


Figure 1 – Schematic view of the selection of the most promising industrial crops to be grown on marginal lands (MAGIC project); a) starting point: 68 industrial crops, b) 37 crops have been selected to be included to MAGIC-CROPS database, c) 31 crops had been included in the multi-criteria analysis of task 1.3 and d) a total number of 20 crops have been selected (13 lignocellulosic (perennial grasses and woody species), 5 oilseeds (and/or specialty crops) and 2 carbohydrate ones.

1 Starting point for the selection

During the 2nd technical meeting in Athens (27th and 28th of November 2017) the work package leader of WP1 (Dr. Andrea Monti; University of Bologna) presented an initial list of promising industrial crops that can be grown on marginal lands. This list contained 68 industrial crops that presented in the table below.

Table 1 - Initial list of the industrial crops that could be grown on marginal lands

	Latin name	Family	Common name	Category
1	*Sorghum bicolor* L.	Poaceae	Biomass sorghum (sweet / fiber)	Lignocellulosic (annual herbaceous)
2	*Camelina sativa* L.	Brassicaceae	Camelina	Oilseed
3	*Crambe abyssinica*	Brassicaceae	Crambe	Oilseed
4	*Ricinus communis* L.	Euphorbiaceae	Castor	Oilseed
5	*Panicum virgatum* L.	Poaceae	Switchgrass	Lignocellulosic
6	Miscanthus x Giganteus	Poaceae	Miscanthus	Lignocellulosic
7	*Arundo donax* L.	Poaceae	Giant reed	Lignocellulosic
8	*Helianthus tuberosus* L.	Asteraceae	Jerusalem artichoke	Carbohydrate
9	*Agropyron elongatum*	Poaceae	Tall wheat grass	Lignocellulosic (perennial grass)
10	*Lunaria annua* L.	Brassicaceae	Honesty	Oilseed
11	*Coriandrum sativum* L.	Apiaceae	Coriander	Specialty
12	*Amaranthus retroflexus* L.	Amaranthaceae	Amaranth	Multipurpose
13	*Carum carvi* L.	Apiaceae	Caraway	Specialty
14	*Calendula officinalis* L.	Asteraceae	Pot marigold	Oilseed/Specialty
15	*Dimorphoteca pluvialis* L.	Asteraceae	Rain daisy	Oilseed/Specialty
16	*Helianthus annus* L.	Asteraceae	Sunflower	Oilseed
17	Stokesia laevis	Asteraceae	Stokes aster	Oilseed
18	*Chicorium intybus* L.	Asteraceae	Chichory	Oilseed/Specialty
19	Borago officinalis L.	Boraginaceae	borage	Oilseed/Specialty
20	*Echium vulgare* L.	Boraginaceae	bugloss	Oilseed/Specialty
21	*Linum usitatissimum* L.	Linaceae	Flax	Multipurpose (oilseed/fibre)
22	*Hibiscus cannabinus* L.	Malvaceae	Kenaf	Lignocellulosic (fiber)
23	*Brassica napus* L.	Brassicaceae	Rapeseed	Oilseed
24	*Brassica carinata*	Brassicaceae	Ethiopian mustard	Oilseed
25	*Isatis tinctoria* L.	Brassicaceae	Woad	Oilseed
26	*Cannabis sativa* L.	Cannabinaceae	Hemp	Multipurpose (fiber/Oilseed)
27	*Crotalaria juncea*	Fabaceae	Sunn hemp	Lignocellulosic
28	*Chenopodium quinoa*	Amaranthaceae	Quinoa	Oilseed/ Carbohydrate
29	*Euphorbia lathyris* L.	Euphorbiaceae	Caper spurge	Specialty
30	*Knautia arvensis*	Caprifoliaceae	Field scabious	Specialty
31	*Euphorbia lagascae* Spreng	Euphorbiaceae	Caper spurge	Specialty
32	*Limnanthes alba*	Limmanthaceae	Meadowfoam	Oilseed/ Specialty
33	*Cuphea* spp.	Lythraceae	Cuphea	Oilseed
34	Althaea spp. / Malva spp.	Malvaceae	mallows	Oilseed/ Specialty
35	*Oenothera* spp.	Onagraceae	Evening primrose	Specialty
36	*Papaver somniferum* L.	Papaveraceae	Poppy	Specialty

37	*Phalaris arundinaceae* L.	Poaceae	Reed canary grass	Lignocellulosic/Specialty
38	*Phragmites australis*	Poaceae	Common reed	Lignocellulosic
39	*Spartium junceum* L.	Fabaceae	Spanish broom	Multipurpose
40	*Stipa tenacissima* L.	Poaceae	esparto grass	Lignocellulosic/ Specialty
41	Spartina spp.	Poaceae	cordgrass	Lignocellulosic
42	*Carthamus tinctorius* L.	Asteraceae	Safflower	Oilseed
43	Pyrethrum cinerariaefolium	Asteraceae	Pyrethrum	Oilseed/Specialty
44	*Simmondsia chinensis*	Simmondsiaceae	Jojoba	Specialty
45	*Urtica dioica* L.	Urticaceae	Nettle	Multipurpose (fiber/speciatly)
46	*Cynara cardunculus* L.	Asteraceae	Cardoon	Lignocellulosic (perennial herbaceous)
47	*Parthenium argentatum*	Asteraceae	Guayule	Multipurpose
48	*Beta vulgaris* L.	Amaranthaceae	Energy (industrial) beet	Carbohydrate
49	*Musa textilis*	Musacaceae	Abaca	Multipurpose
50	*Thlaspi arvense* L.	Brassicaceae	Pennycress	Oilseed
51	*Salix* spp	Salicaceae	Willow	Lignocellulosic (woody species)
52	*Populus* spp	Salicaceae	Poplar	Lignocellulosic (woody species)
53	Betula spp	Betulaceae	Birch	Lignocellulosic (woody species)
54	*Robinia pseudoacacia* L.	Fabaceae	Acacia	Lignocellulosic (woody species)
55	Agave spp.	Asparagaceae	Agave	Specialty
56	*Leymus cinereus*	Poaceae	basin wildrye	Lignocellulosic (perennial grass)
57	*Leymus triticoides*	Poaceae	creeping wildrye	Lignocellulosic (perennial grass)
58	*Thinopyrum intermedium*	Poaceae	intermediate wheatgrass	Lignocellulosic (perennial grass)
59	*Penisetum glaucum*	Poaceae	pearl millet	Lignocellulosic (perennial grass)
60	*Saccharum spontaneum* L.	Poaceae	Wild sugarcane	Lignocellulosic (perennial grass)
61	*Brassica juncea*	Brassicaceae	Indian mustard	Oilseed
62	*Eucalyptus* spp.	Myrtaceae	Eucalyptus	Lignocellulosic (woody species)
63	*Hippophae ramnoidea* L.	Elaeagnaceae	Sea buckthorn	Specialty
64	*Silphium perfoliatum* L.	Asteracea	Cup plant	Specialty/Lignocellulosic
65	*Nicotiana glauca* L.	Solanaceae	Wild tobacco	Multipurpose
66	Opuntia spp.	Cactacaceae	Opuntia	Multipurpose
67	*Ulmus pumila* L.	Ulmaceae	Siberian elm	Lignocellulosic (woody species)
68	*Artiplex* spp.	Amaranthaceae	Artiplex	Multipurpose

The above list was presented and discussed by the partners and a total number of 37 crops had been selected to be included in MAGIC-CROPS database. In table 2 these crops are being presented.

Table 2 - List of the selected crops for the multi-criteria analysis (name, origin, where can be grown in Europe, why can be grown on marginal lands, crop category and products and markers).

	Name (common & Latin) and family	Origin	Where can be grown in Europe	References about its suitability to be grown on marginal lands	Category	Products and markets
1	**Sorghum (sweet/fiber)** *Sorghum bicolor* L. Poaceae	Northern Africa	South (S), Central (C)	High drought resistant crop, deep rooting system, can be grown on toxic soils. Currently, is being investigated in **BeCool** project (www.becoolproject.eu). Recently, had been evaluated in **Sweetfuel** project (www.sweetfuel-project.eu).	Carbohydrate, Lignocellulosic (annual)	Bioethanol production (1st generation and advanced biofuels), biogas production, animal feed, human feed. Fiber sorghum is a great fiber source.
2	**Camelina** *Camelina sativa L.* Brassicaceae	Southern Europe	South (S), Central (C), North (N)	In **ITAKA** project (www.itaka-project.eu), it had been cultivated on ***marginal lands*** in Spain for aviation biofuels. Currently, in **COSMOS** project (http://cosmos-h2020.eu) the best cultural practices in several sites in EU are being investigated. It exists both winter and spring varieties, winter camelina can resist up to -20°C.	Oilseed (annual)	Its oil seeds characterized by high content of erucic acid). Its oil has a large variety of high-added value bioproducts (chemical industry). The cake of the seeds has high protein content and is a valuable source for animal feeding.
3	**Crambe** *Crambe abyssinica* L. Brassicaceae	Eastern Africa domesticated in Mediterranean	South (S), Central (C), North (N)	Relatively drought tolerant, it tolerates soil pH from 5.0 to 7.8. It can be adapted to ***marginal land*** areas with mild winters as an autumn crop, or as a spring one in short season environments. Currently, in **COSMOS** project (http://cosmos-h2020.eu) the best cultural practices in several sites in EU are being investigated.	Oilseed (annual)	Its oil has high erucic acid and has several industrial applications, while the seed cake can be used for soil bio fumigation.
4	**Castor bean** *Ricinus communis* L. Euphorbiaceae	Mediterranean area	South (S)	It cannot tolerate low temperatures. It can be grown on ***marginal lands*** (grows best on moderately fertile), which are not	Oilseed (annual or perennial)	Source of ricin oleic acid, several chemical and medicinal applications. Its oil has

				competitive with food (economic viable solution for non-productive lands). It can tolerate pH 5.5-6.5 and saline soils.		international market with more than 700 uses. Castor cake can be used as nematicide
5	**Switchgrass** *Panicum virgatum* L. Poaceae	Native of USA	South (S), Central (C), North (N)	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.	Lignocellulosic (perennial with lifespan 10-20 years).	Solid biofuels, advanced biofuels, other industrial applications.
6	**Miscanthus** *Miscanthus x giganteus* Poaceae	Native of Asia	South (S), Central (C), North (N)	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 (**BBI, Demo**) to be grown on marginal lands and/or contaminated lands.	Lignocellulosic (perennial with lifespan 10-20 years).	Solid biofuels, advanced biofuels, other industrial applications
7	**Giant reed** *Arundo donax* L. Poaceae	Mediterranean area	South (S)	It has been selected by OPTIMA project (www.optimafp7.eu) as a promising crop to be grown on ***marginal lands***. Before that it had been investigated in **Bioenergy Chains** project (www.cres.gr/bioenergy_chains) on ***marginal lands***.	Lignocellulosic (perennial with lifespan 10-20 years).	Solid biofuels, advanced biofuels, other industrial applications.
8	**Tall wheatgrass** *Agropyron elongatum* Poaceae	Native of Eurasia	South (S)	A very tolerant plant, able to grow in a wide range of conditions. It succeeds in soils with a **pH of 5.3 - 9.0**, and thrives in areas subject to ***inundation by saline water***, such as seashores and saline meadows as well as on alkaline soils.	Lignocellulosic (perennial crop)	It is used as forage and for hay in many places. Source of biomass (lignocellulose). It can be used for soil reclamation.
9	**Amaranth** *Amaranthus* spp. Amaranthaceae	Many species	South (S), Central (C)	It is considered ***drought tolerant crop***. It is considered only of the easiest crops to be cultivated on agricultural marginal lands.	Carbohydrate Specialty / Medicinal uses (annual)	It can be used as alternative of wheat.
10	**Sunflower**	Native of north	South (S),	It is considered ***drought tolerance crop***.	Oilseed (annual)	Oil from its seeds (edible uses

	Helianthus annus L. Asteraceae	America	Central (C)	It has a tap rooting system. It is an important crop for the Mediterranean region for biodiesel production.		as well as first generation biofuels)
11	**Ethiopian mustard** *Brassica carinata* L. Brassicaceae	Native of Africa (Ethiopia)	South (S)	It is considered ***drought tolerance crop***. Soils with pH 5.5-8.0. It had been tested in **FAIR981946** project (1998-2001).	Oilseed (annual)	Its oil has high erucic acid and has several industrial applications, while the seed cake can be used for soil bio fumigation.
12	**Industrial hemp** *Cannabis sativa* L. Cannabinaceae	Central Asia	South (S), Central (C), North (N)	Currently has been selected by **GRACE** project (BBI, Demo) as industrial crop for ***marginal lands***. It had been investigated in **MULTIHEMP** project (http://multihemp.eu). In Poland had been used for soil reclamation.	Oilseed/Fiber crop/Multipurpose (annual)	Multipurpose crop, from its stems (fibers, paper and pulp, building materials, insulation mats, etc.), from its seeds (oil, seeds…)
13	**Flax** *Linum usitatissimum* L. Linaceae	South Europe, near East and/or central Asia	South (S), Central (C), North (N)	It has very shallow rooting system. In India and China has been often grown on ***marginal lands*** and rarely received adequate fertilization. Best grown on soils with pH 6.0.	Oilseed/Fiber crop/Multipurpose (annual)	Several industrial applications from its oilseeds and its fiber stems. Important nutraceutical and pharmaceutical uses. In EPOXY project (www.ecoxy.eu, BBI) value added products produced from flax.
14	**Reed canary grass** *Phalaris arundinaceae* L. Poaceae	North of Europe (perennial crop with lifespan 10-15 years)	Central (C), North (N)	It is reported as appropriate to be cultivated on ***marginal lands*** of the north (where it can grow well on both dry and wet areas), pH 4.9 to 8.2.	Lignocellulosic; 20000 ha in North of Europe.	Solid biofuels, advanced biofuels, other industrial applications.
15	**Common reed** *Phragmites australis* *Poaceae*	It is considered cosmopolitan species	Central (C), North (N) South (S)	It prefers to grow on wet areas (such as pounds and lakesides).	Lignocellulosic	It can be used for phytoremediation water treatment.
16	**Spanish broom** *Spartium junceum* L. Fabaceae	Native of Mediterranean region	South (S)	It can be easily found in South Europe in sunny and dry areas with sandy soils.	Lignocellulosic/Specialty crop	Multipurpose crop, from its stems (fibers, paper and pulp, building materials, insulation mats, etc.). From the flowers it is possible to extract compounds with pharmaceutical applications.

17	**Safflower** *Carthamus dictorius* L. Asteraceae	It can be found in Asia, Africa and Europe.	South (S), Central (C)	It has a ***strong taproot and thus thrives in dry climates***. It can be cultivated as both winter and spring crop.	Oilseed	Seeds (birdfeed), Oil (edible), dyes, medicines, etc.
18	**Nettle** *Urtica dioica* L. Urticaceae	Native of Europe, Asia, northern Africa, and western North America	South (S), Central (C), North (N)	It prefers to be grown on waste ground, hedgerows, woods etc. It prefers a rich soil and avoids acid soils. It is an invasive perennial crop.	Fiber crop/ Multipurpose	It has several fiber applications as well as several medicinal uses. Due to numerous possible applications it is a multipurpose crop.
19	**Cardoon** *Cynara cardunculus* L. Asteraceae	South Europe (perennial 5-10 years; established by seeds)	South (S)	Drought resistant crop can be cultivated on ***arid marginal areas*** of south EU with the most recent example **FIRST2RUN** project (www.first2run.eu; BBI project, Flagship) and **OPTIMA** (FP7 project).	Oilseed/Lignocellulosic/Multipurpose	From its seeds: oil, protein flour, active molecules. From its stems: solid biofuels (energy), paper and pulp, other chemicals, etc. From its roots: organic substances, chemicals, etc.
20	**Guayule** *Parthenium argentatum* *Asteraceae*	Native of South Western USA	South (S)	It grows well in arid and semi-arid areas. It grows in areas where food crops would fail. It is ***considered low input crop***.	Specialty	Source of latex and resin.
21	**Pennycress** *Thlaspi arvense* L. Brassicaceae	Native to temperate regions of Eurasia	South (S), Central (C), North (N)	It has a short growing cycle (shorter than camelina) and it can be cultivated as a winter annual crop on ***unused land***. Low demand on soil and water nutrition and water. It is really frost tolerant (up to -20°C). Nowadays, it is been investigated as a promising oilseed crop in USA.	Oilseed	Oilseed for biodiesel production and aviation biofuels. Its seedcake has high protein content and can be used for bio fumigation.
22	**Willow** *Salix spp*.	Native of North Europe	Central (C), North (N)	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.	Lignocellulosic (short rotation forestry)	Solid biofuels, advanced biofuels, biobased products (construction materials, packaging materials, etc.) paper & pulp.
23	**Poplar** *Populus* spp. Salicaceae	Native to most of the northern Hemisphere	South (S), Central (C), North (N)	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	Lignocellulosic (short rotation forestry)	Solid biofuels, advanced biofuels, biobased products (construction materials, packaging materials, etc.) paper & pulp.

				Dedromas4Europe project (BBI, Demo).		
24	**Black locust** *Robinia pseudoacacia* L. Fabaceae	Native to eastern USA	South (S), Central (C)	It has high drought resistance and is nitrogen fixing. It is suitable for soil regeneration and reclaiming former mining sites. It has high ability to be grown on ***marginal lands***.	Lignocellulosic (short rotation forestry)	Solid biofuels, advanced biofuels, biobased products (furniture, construction materials, packaging materials, etc.) paper & pulp.
25	**Eucalyptus** *Eucalyptus* spp. Myrtaceae	Native to Australia	South (S)	Most species of eucalyptus tolerate poor soils. Eucalyptus can be grown on soils of high pH. It is a drought tolerant crop.	Lignocellulosic (short rotation forestry)	Paper and pulp, solid biofuels, pharmaceutical /nutraceutical uses from its oil. In **EUCALIVA** project (www.eucaliva.eu, BBI) produced advanced material and carbon fibers from Eucalyptus wastes (lignin).
26	**Siberian elm** *Ulmus* pumila L. Ulmaceae	Native to central Asia	South (S), Central (C), North (N)	Ulmus pumila is often found in ***abundance along railroads*** and in abandoned lots and on disturbed ground.	Lignocellulosic (perennial crop)	Solid biofuels, advanced biofuels, biobased products paper & pulp.
27	**Wild sugarcane** *Saccharum spontaneum* L. Poaceae	Native to ?	South (S), Central (C)	It had been tested in **OPTIMA** project (www.optimafp7.eu) as a native perennial grass that can be grown on marginal lands in the Mediterranean region.	Lignocellulosic	Solid biofuels, advanced biofuels, other industrial applications
28	**Lupin** *Lupinus mutabilis* Fabaceae	Native of Andean region of Ecuador, Peru and Bolivia.	South (S), Central (C)	It has been selected by **LIBBIO project** as an industrial crop that can be grown on ***marginal lands*** (www.libbio.net). It tolerates the acid soils and it is considered drought tolerance.	Oilseed/Multipurpose	Oil (20%) and protein (40%) can be obtained from lupin seeds.
29	**Wild tobacco (tree)** *Nicotiana glauca* Solanaceae	Native of South America		In **multibiopro** project (www.multibiopro.eu) wild tobacco has been selected as non-food crop that can be grown on marginal lands.	Oilseed	Several medicinal uses. It has been investigated as source for biodiesel production. High value biobased products.
30	**Saltbush** *Atriplex spp*. Amaranthanceae	Native to Asia and Europe	South (S), Central (C), North (N)	It can grow on ***saline and alkaline soils***. It has been used for reclamation of saline soils as well as for rehabilitating eroded or scorched soils.	Lignocellulosic/multipurpose (perennial crop)	It fodder crop for saline soils.
31	**Jerusalem artichoke** *Helianthus tuberosus* L.	Native of eastern of	South (S), Central (C),	It can be grown on ***saline soils*** and tolerates soils with pH 4.5-8. It can be	Carbohydrate (perennial	Source of inulin, food and feed use. It can be used for

	Asteraceae	Northern America	North (N)	used for soil for ***soil reclamation in disturbed industrial sites***.	herbaceous crop).	bioethanol production.
32	**Kenaf** *Hibiscus cannabunus* L. Malvaceae	Native of Africa	South (S)	It is better adapted to poor and/or marginal lands compared to many commercial (food and feed) crops. In **BIOKENAF** project (www.cres.gr/biokenaf) when cultivated on ***marginal soils*** gave 12t/ha DMY.	Oilseed/Fiber crop/ Multipurpose (annual)	Several industrial applications from its fiber stem (insulation mats, building & absorption materials, paper & pulp, etc.)
33	**Sunn hemp** *Crotalaria juncea* L. Fabaceae	Native of India, native of tropics	South (S)	It can perform well on sandy poor soils. It can grow best on soils with pH 5 to 7.5. It can be grown in rotation to kenaf. It is a leguminous crop. Currently, is being investigated in **BeCool** project (www.becoolproject.eu).	Lignocellulosic crop (annual fiber crop)	Green manure, fodder, source of fiber
34	**Caper spurge / euphorbia** *Euphorbia lagascae* L. Euphorbiaceae	Native of South Europe	South (S)	It is considered as ***drought tolerance*** crop. It seems tolerant to damp sites of saline nature.	Oilseed	50% oil in the seeds (80-90% of oil is oleic acid). Medicinal uses. Source of latex.
35	**Sugar beets** *Beta vulgaris* Amaranthaceae	Important crop for Europe (from 18th century)	South (S), Central (C)	**Pulp2Value** project (http://pulp2value.eu, BBI) demonstrates an integrated biorefinery system to refine sugar beet pulp to high value biobased products.	Carbohydrate	20% of the sugar world production is from sugar beets.
36	**Calendula** *Calendula officinalis* L. Asteraceae	Mediterranean area, can be grown on temperate regions of EU	South (S), Central (C)	It has ***deep tap root system***. It can be grown in soils with pH 5.5-7.0.	Oilseed/Specialty (high percentage of calendic acid)	It has several applications (medicinal uses, coatings, paints, varnishes, cosmetics, etc.)
37	**Lavender** *Lavandula angustifolia* L. Lamiaceae	Native of the Mediterranean region	South (S), Central (C)	It thrives in any poor or moderately fertile, free-draining soils in full sun, and is ideal for chalky or alkaline soils	Specialty (perennial herbaceous)	Several applications (nutraceutical, pharmaceuticals, etc.)

2 Multi-criteria analysis

In the descrioption of action (DoA) of the project it has been written that the criteria for the multicriteria analysis should be: a) maturity of knowledge on industrial crops on marginal land, crop performance for bio-based products, b) crops' productivity on marginal land, c) TRL of mechanical cultivation, d) crop adaptability under specific combinations of natural constrains in each M-AEZ, e) industry needs and f) market opportunities. Each criterion should be marked in a scale 1 to 5. During the 2nd technical meeting the above criteria presented and critically discussed and modified. The final criteria that the multi-criterial analysis had been carried out were:

1. **Experience with agricultural management of the proposed industrial crops (20%)** ***potential***
2. **Crop productivity for industrial applications (according to the main uses) (20%)** ***potential***
3. **Expected crop performance on marginal land (30%)** ***knowledge***
4. **Industry needs (15%)** ***commercial***
5. **Market opportunities (15%)** ***commercial***

It was also discussed if the above five criteria should have the same weight in the total score. After a lot of discussion it was agreed the first two to have a weight of 20%, the third to have 30% and the last two to have 15% each.

During the same meeting it was also discussed who should contribute to this multi-criteria analysis. Initially, it was discussed the idea to be distrusted to the work package leaders and finally it was agreed to be distributed to the whole consortium since its majority have very long experience on industrial crops covering the whole production chain. In mid-December 2017 the table with the multi-criteria analysis (containing 31 industrial crops that had been included in table 3) had been sent to the consortium and the answers had been given by the end of January 2018. All answers had been counted and the results of this multi-criterion analysis are presented in table 3.

Although, the initial plan was the list of the most promising crops to contain up to 15 industrial crops it was finally decided to contain 20 since the crops that had been sorted out from place 16th to 20th were either crops that are being funded by EU in the view of EU projects (such as lupin in LIBBIO) or crops that some of the partners have carried out trials on marginal lands and they have sound results that supporting the idea to be tested by other members of the consortium in other EU regions/countries (sugarcane, Siberian Elm, crambe and Black locust).

Table: 3 - Results from the multi-criterial analysis

	Experience with agricultural management of the proposed industrial crops (20%) *potential*	Crop productivity for industrial applications (according to the main uses) (20%) *potential*	Expected crop performance on marginal land (30%) *knowledge*	Industry needs (15%) *commercial*	Market opportunities (15%) *commercial*	Final score
Sorghum	4.875	4.875	4.500	4.375	4.500	4.631
Camelina	4.900	4.700	4.300	3.600	4.400	4.410
Crambe	4.000	4.000	3.800	3.400	3.200	3.730
Castor	5.000	5.000	4.500	4.500	4.500	4.700
Switchgrass	4.625	4.750	4.875	4.375	4.625	4.687
Miscanthus	4.200	4.800	4.400	4.200	4.700	4.455
Giant reed	3.785	4.500	4.625	4.375	4.750	4.431
Tall Wheat grass	4.500	4.500	4.833	4.000	4.833	4.575
Amaranth	2.167	2.833	3.167	3.000	3.667	2.950
Sunflower	4.300	3.800	3.300	3.200	3.200	3.570
Ethiopian mustard	4.250	4.125	4.000	4.375	4.250	4.168
Hemp	4.700	4.500	3.600	4.300	4.600	4.255
Flax	4.667	3.583	2.583	4.417	3.833	3.633
Reed canary grass	4.875	5.000	4.625	4.250	4.250	4.637
Common reed	2.375	3.625	3.875	3.375	2.625	3.263
Spanish broom	1.500	1.167	3.167	2.500	2.500	2.233
Safflower	4.167	4.333	4.333	4.167	4.833	4.350
Nettle	1.333	2.667	3.167	2.167	2.500	2.450
Cardoon	4.500	4.833	4.833	4.167	4.833	4.667
Guayule	3.125	3.625	3.125	3.500	4.125	3.431
Pennycress	4.167	3.833	4.500	3.833	4.667	4.225
Willow	4.583	3.917	4.333	4.000	3.750	4.163
Poplar	4.500	4.083	4.083	4.417	3.917	4.192
Black locust	3.200	3.900	3.900	4.300	4.300	3.880
Eucalyptus	3.833	3.833	3.000	4.167	4.167	3.683
Siberian Elm	3.677	3.667	4.333	4.333	4.667	4.117
Lupin	4.400	3.520	3.500	3.600	3.600	3.714
Wild tobacco	2.250	3.125	3.250	2.375	2.750	2.819
Saltbush	2.000	2.667	4.433	2.000	2.000	2.833
Wild sugarcane	3.000	4.167	4.667	4.333	4.500	4.158

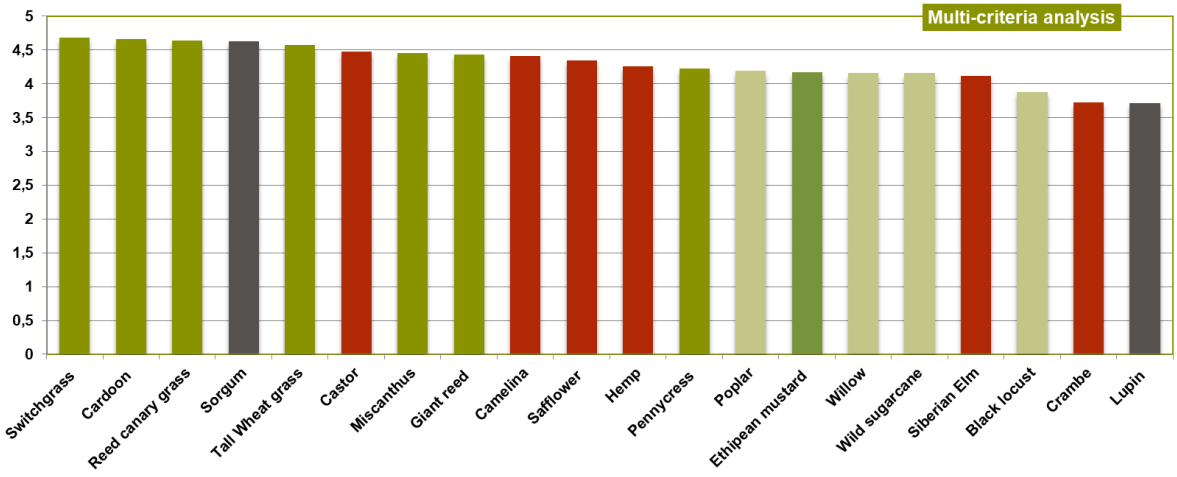


Figure 2 – Top 20 industrial crops that have been selected as the most promising to be grown on marginal lands facing natural constaints.

The final list of the 20 selected most promising crops is presented in Figure 2. In this list they were 6 perennial lignocellulosic crops, 7 oilseeds, 5 woody species and 2 carbohydrate crops. Some of the selected crops can be grouped in more than one categories and can be considered as multipurpose crops (figure 3). Eight of the selected crops can be grown by all partners (covering almost all Europe; figure 4).

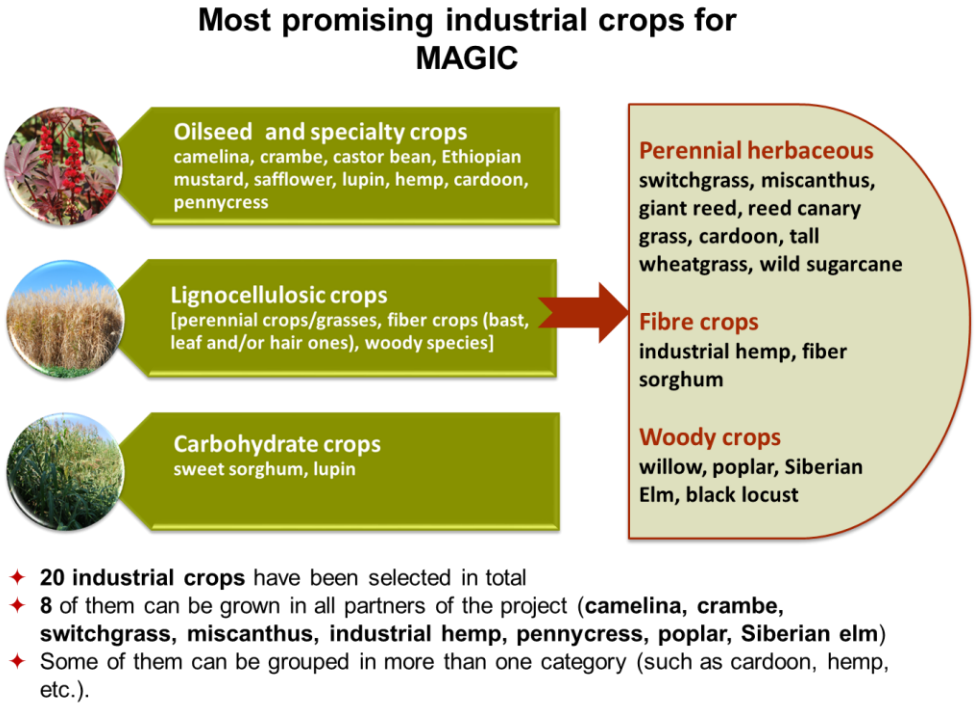
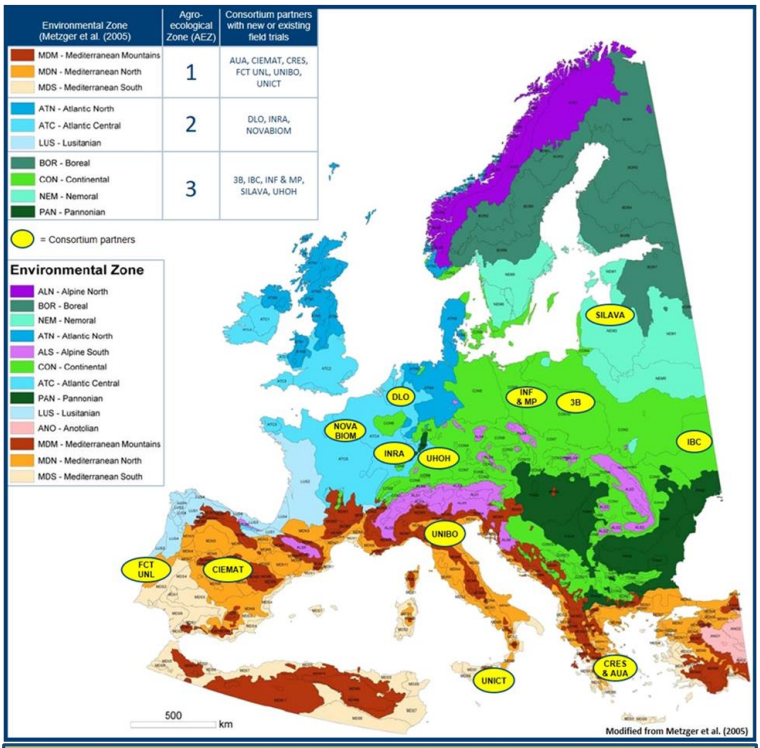


Figure 3 – The final selected most promising industrial crops can be grouped in: oilseeds and specialty crops, lignocellulosic crops (perennial herbaceous, fiber crops and woody species) and carbohydrate.



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

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

*These crops can be cultivated in all Europe.

Figure 4 – Final selected industrial crops; 8 of them can be grown in whole Europe, while the rest can be grown in South or in north. In the map presented where the project partners are located and where the crops will be grown.