



Promising oilseed crops for Europe: which could be grown on marginal lands?

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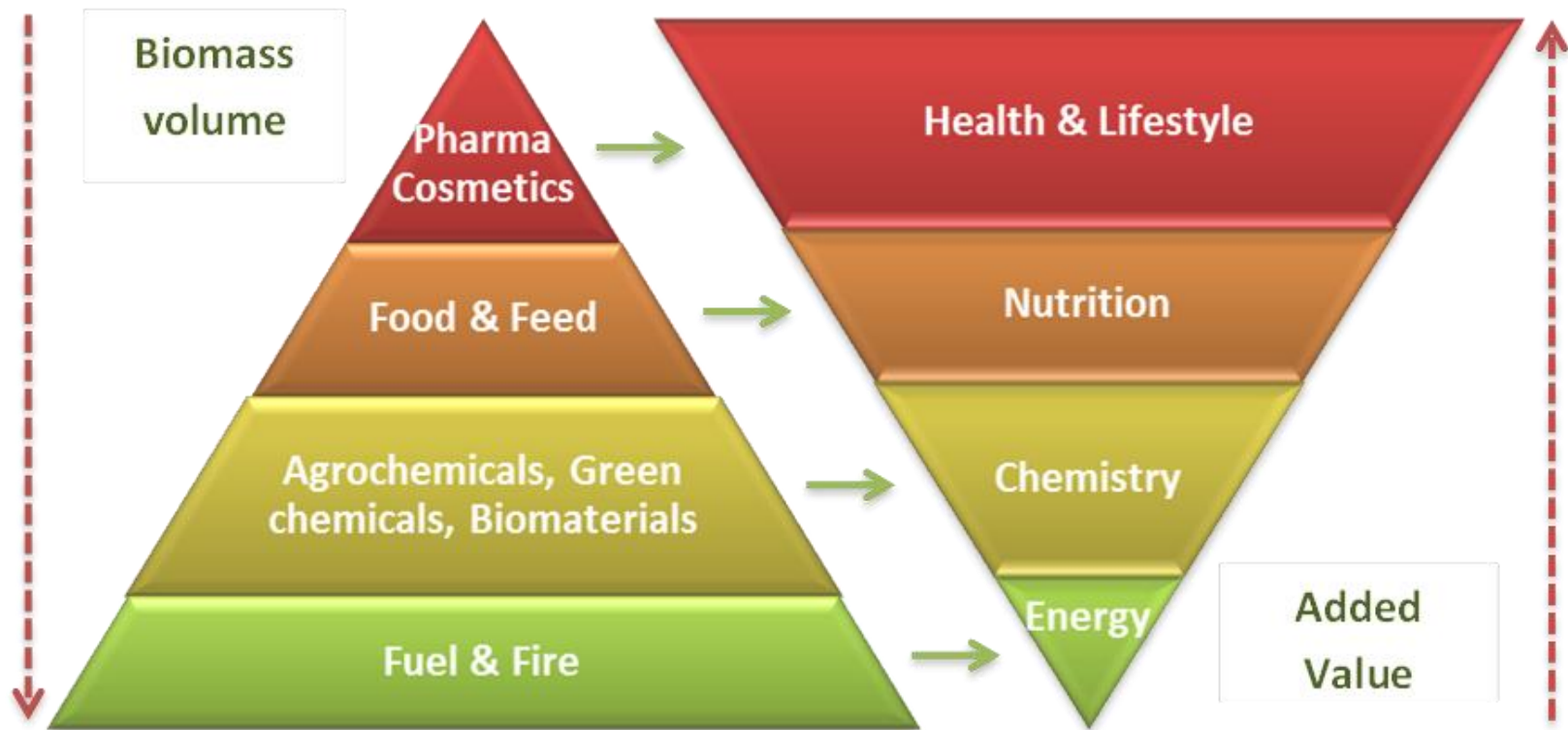
Value chain event on oilseeds (27/3/19)
Imperial College London



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The importance of oilseed crops for Europe; offering source for a large number of value-added products and biofuels



Facts and projections

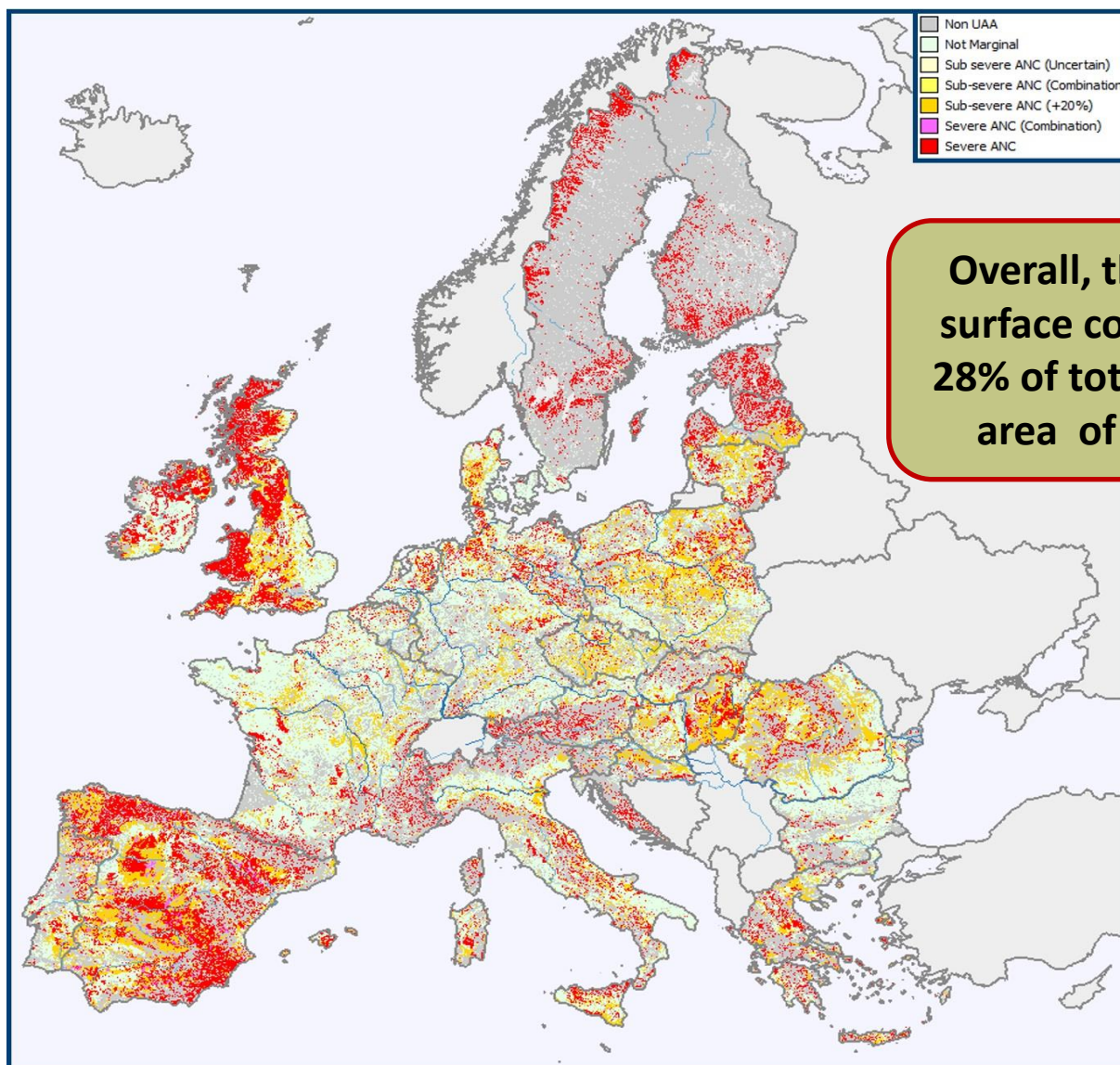
Facts

- ✦ Two **oilseed crops** are being cultivated in Europe for **first generation biofuels** (rapeseed and sunflower).
- ✦ **Flaxseed** and **industrial hemp** are being grown in smaller areas in Europe for value-added applications.

Projections

- ✦ It has been estimated that in EU up to **30% of the mineral oil-based chemicals and materials** would be replaced with bio-based alternatives by 2030 (BBI, 2014).
- ✦ The **EU bio-plastics market** was estimated at around 485 million € in 2013 with a potential increase to 900 million € in 2017 and to 1.4 billion in 2020, (55% increase).
- ✦ The **bio-lubricants market**, valued 410 million € in 2010, will reach to 640 million euros in 2020 (growth 56%).
- ✦ The market for **bio-based surfactants** is expected to increase to about 1.3 billion € in 2030; while currently is 680 million euros (growth 91%).

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



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

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.

Final selection of the top 20 crops as the most promising ones to be grown on marginal lands

37 crops had been selected to be included in the database of the project

67 industrial crops that had been selected from previous research projects

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

In the MAGIC-CROPS database a total number of 13 oilseeds crops (and/or multipurpose crops have been included

Following a multi-criteria analysis eight crops have been selected as the most promising ones to be grown on marginal lands.

These crops are:
camelina, safflower, castor, crambe, pennycress, industrial hemp, cardoon and lupin

Camelina (*Camelina sativa* L.)

Family: Brassicaceae



Camelina in Greece; COSMOS project (CRES)



Camelina in Poland; COSMOS project (UWM)

- ✦ Annual, short growing cycle (90-120 days), winter and spring crop, native to Europe.
- ✦ Currently, is being included in two EU projects: COSMOS & BIO4A.
- ✦ In ITAKA project (www.itaka-project.eu) cultivated on marginal lands in Spain for aviation biofuels.
- ✦ A lot of research worldwide and many references for its suitability to be grown on marginal lands.
- ✦ Its oil have high erucic acid (many industrial uses).
- ✦ Seed yields: COSMOS - 2 t/ha (varied from 1 to 3t/ha). ITAKA - 0.5 to 2.5 t/ha.
- ✦ Oil content (%): 38 to 42%
- ✦ 90 % of the oil corresponding to unsaturated fatty acids (30-40% alpha linolenic acid, 15-25% linoleic acid, 15% oleic acid and 15% eicosenoic acid).

Crambe (*Crambe abyssinica* L.)

Family: Brassicaceae



- Seed yields: In COSMOS project the mean seed yields were 2.3 t/ha (varied from 0.6 to 3.1t/ha).
- Oil content: In dehulled seeds the oil content could be up to 54%, while it is quite lower (25-33%) in non dehulled. The content of erucic acid on the seed oils varies from 55 to 60%.
- On a dry basis, whole crambe seed contained 33.9% oil, 25.2% protein, and 12.3% crude fiber

- ✦ Annual spring crop, growing cycle 85-105 days, domesticated to Mediterranean region.
- ✦ Relatively drought tolerant, tolerates pH from 5.0 to 7.8. It can be adapted to marginal land areas .
- ✦ Like camelina, crambe have been selected by COSMOS project (<http://cosmos-h2020.eu>) as alternative oils sources to EU imported oils (palm, coconut). Oil rich to erucic oil.



Camelina in Poland; COSMOS project (UWM)



Castor bean (*Ricinus communis* L.)

Family: Euphorbiaceae



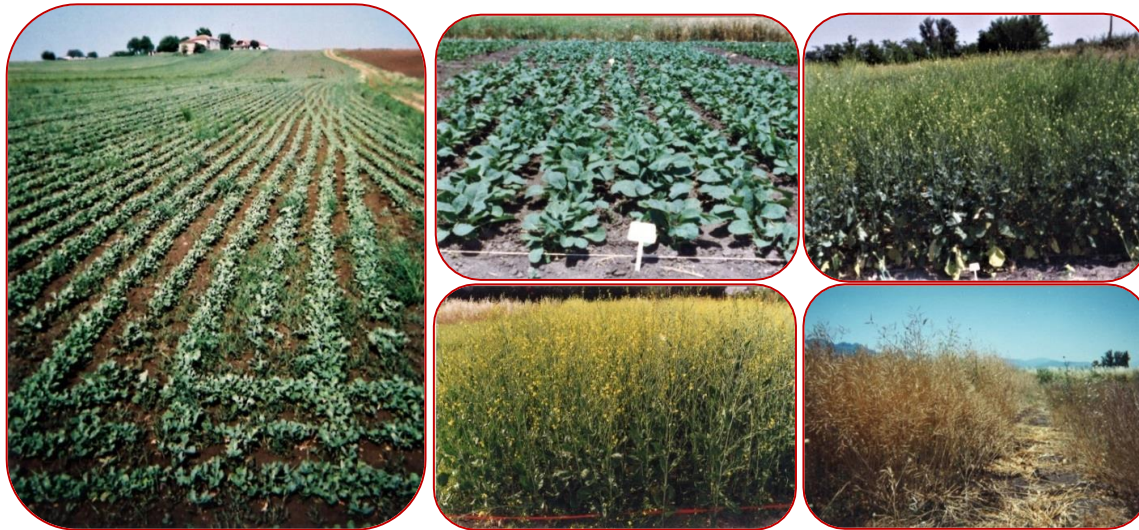
Comparison between Greek genotypes and new hybrids produced by KAIIMA company (Israel)

- ✦ Annual or perennial and indigenous in the Med. zone.
- ✦ As annual spring crop needs 120-150 days to reach the harvesting time.
- ✦ It can be grown on marginal lands, which are not competitive with food (economic viable solution for non-productive lands). It can tolerate pH 5.5-6.5 and saline soils but not low temperatures.
- ✦ It had been tested in EUROBIOREF project.
- ✦ Although, Europe is the main importer of castor oil, it is still not cultivated.
- ✦ Valuable source for ricin oleic acid. Its oil has international market with more than 700 uses.

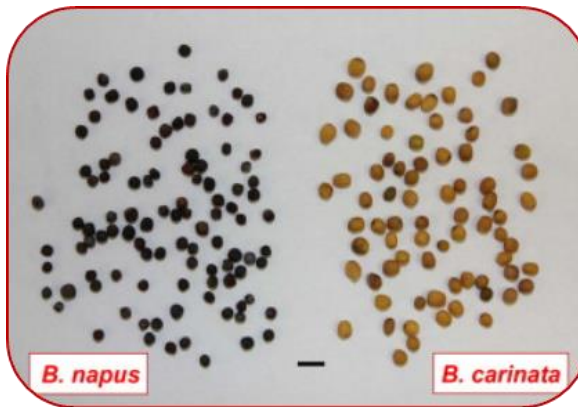


Ethiopian mustard (*Brassica carinata* L.)

Family, Brassicaceae



Ethiopian mustard at several stages of growth; Greece



- ✦ It is considered drought tolerance crop and thus it is a promising crop for the Mediterranean region and for areas with dryness problems.
- ✦ Soils with pH 5.5-8.0.
- ✦ It has been tested in some EU projects and the most recent is ICON.
- ✦ Seed yields: 2 to 3t/ha in Canada. In the Greek trials (FAIR CT96 1946 project) the seed yields of the compared lines came up to 1.5 t/ha. In general the oil content is 40%.
- ✦ Its oil has high erucic acid and has several industrial applications, while the seed cake can be used for soil bio fumigation.

Safflower (*Carthamus dictorius* L.)

Family: Asteraceae



- ✦ Seed yields: 2 to 3.5 t/ha.
- ✦ Oil content: 34 and 36%.
- ✦ The oil contain 92-93 % unsaturated fat (high quality edible oil).
- ✦ The protein content of the seed meal is 24%



- ✦ It can be grown as winter and spring crop.
- ✦ Growing period 110 to 150 days.
- ✦ It can be grown successfully on dry lands.
- ✦ It has a strong taproot and thus thrives in dry climates.
- ✦ It has gained interest in Spain where it is grown that fluctuated from year to year.
- ✦ The chemical industry interest for the high-oleic varieties.
- ✦ High-oleic varieties have 74-80% oleic acid and the high-linoleic have 70-80% linoleic acid.

Pennycress (*Thlaspi arvense* L.)

Family: Brassicaceae



Pennycress trials in Italy and Greece and harvesting in Illinois



- ✦ Annual winter or spring crop with shorter growing cycle than camelina.
- ✦ It has gained attention in USA as a short cycle crop that can be grown on unused land.
- ✦ Low demand on soil nutrition and water demand.
- ✦ Frost tolerant (up to -20°C).
- ✦ Seed yields varied from 500 to 1000 kg/ha.
- ✦ The oil content of the seeds is 36% and the erucic acid is 38%. The oil contains up to 38 percent erucic and 22 percent linoleic fatty acids.
- ✦ Only few varieties are available such as Elizabeth and MN-106.

Industrial hemp (*Cannabis sativa* L.)

Family: Cannabinaceae



Industrial hemp in Greece and harvesting of the crop in Romania.



- ✦ Annual spring crop.
- ✦ 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.
- ✦ Multipurpose crop, from its stems (fibers, paper and pulp, building materials, insulation mats, etc.), from its seeds (oil, seeds...).
- ✦ The seeds contain 32.5% oil, 70% is corresponding to polyunsaturated fatty acids.

Cardoon (*Cynara cardunculus* L.)

Family: Asteraceae



Cardoon plantations in Greece and Spain (CRES and UPM) and harvesting of the crop by CREA



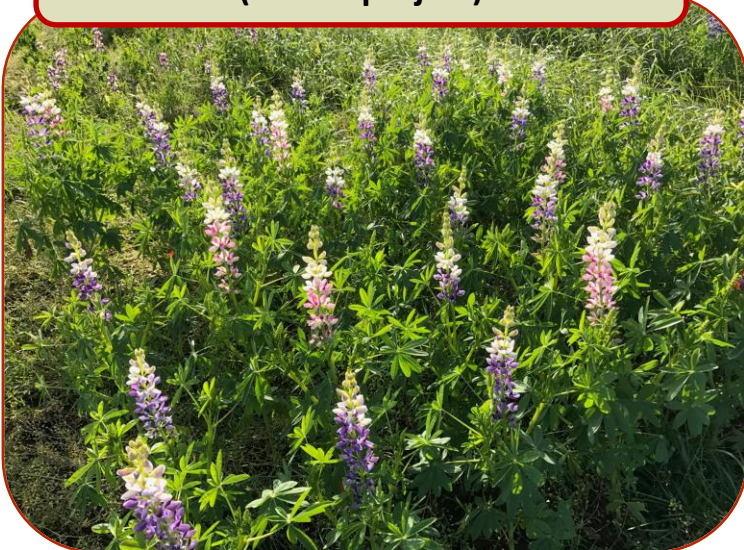
- ✦ Perennial crop (5-15 years). Established by seeds, it regrowth every autumn and should be harvested in mid-August.
- ✦ Drought resistant; it can be grown in whole Mediterranean region.
- ✦ In FIRST2RUN (BBI project) it has been grown in a marginal area in Sardinia for its oilseeds.
- ✦ It has been tested also in OPTIMA and BIOCARD projects.
- ✦ Multipurpose crop and from its seeds: oil, protein flour, active molecules.
- ✦ Seed yields: 1-1.2 t/ha
- ✦ Oil content: 25% oil with fatty acid profile similar to sunflower.

Lupin (*Lupinus mutabilis*)

Family: Fabaceae



View of lupin plantations
(LIBBIO project)



- ✦ Annual crop with growing cycle around 150 days. It is originated from Andes.
- ✦ It has been described as a crop that can be grown on poor and marginal lands. It tolerates the acid soils and it is considered drought tolerance.
- ✦ It has been selected by LIBBIO project as an industrial crop that can be grown on marginal lands (www.libbio.net). Field trials in Greece, Romania, Spain, Portugal, Austria, Iceland and Netherlands.

- ✦ Its seed yields can be up to 5t/ha (varied from 0.5 to 5t/ha).
- ✦ The seeds contain 20% oil, 40% protein.





camelina



crambe



castor



Ethiopian mustard



Safflower



Pennycress

Oilseed
crops



Industrial hemp



Cardoon



Lupin

Multipurpose
crops

Thank you for your attention

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