Advanced Sustainable BIOfuels for Aviation

Deliverable D4.7:

Final Report on the assessment of environmental sustainability indicators for advanced biojet fuel value chains on marginal lands in the Mediterranean (Task 4.3)

Consortium:

Acronym	Legal entity	Role
RE-CORD	CONSORZIO PER LA RICERCA E LA DIMOSTRAZIONE SULLE ENERGIE RINNOVABILI	CO
ENI	ENI S.p.A.	BEN
SKYNRG	SKYENERGY BV	BEN
CENER	FUNDACION CENER-CIEMAT	BEN
ETA	ETA – Energia, Trasporti, Agricoltura Srl	BEN
CCE	CAMELINA COMPANY ESPANA S.L.	BEN
JRC	JOINT RESEARCH CENTRE – EUROPEAN COMMISSION	BEN

CO…Coordinator, BEN…Beneficiary

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1	**30/11/2022**	**Original**			
2	12/12/2022	V2	41	TB	ALL
3	08/04/2023	V3	41	TB	ALL

Document Type

PRO	Technical/economic progress report (internal work package reports indicating work status)	
DEL	Technical reports identified as deliverables in the Description of Work	**x**
MoM	Minutes of Meeting	
MAN	Procedures and user manuals	
WOR	Working document, issued as preparatory documents to a Technical report	
INF	Information and Notes	

Dissemination Level

PU	Public	**x**

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1. Summary

The present deliverable contains the activities related to the following tasks:

- "GIS data of potential Camelina feedstock production on marginal lands in EU MED area"
- "Environmental sustainability of feedstock potential production on marginal land assessed through the measurement environmental sustainability indicators (Soil properties, potential effects of soil amendments for the reduction of Greenhouse Gases GHGs emissions, Water use and efficiency, Soil Biodiversity proxies, and Land use change)"

It develops around the modelling exercise performed on the prediction of Camelina yields in rotation with Barley in Mediterranean marginal land in the D2.7 deliverable: Assessment of potential for drought-resistant oil crop in marginal land of Southern Europe and abroad.

Bioenergy crops and specifically Camelina has the potential to be grown profitably on these lands and can therefore offer a source of income to local actors while contributing to achieving the targets of the Renewable Energy Directive (EC/2009). Bioenergy offers an alternative source of income for farmers and can contribute to the energy resilience of a country. The GIS analysis has highlighted the more productive Nomenclature of territorial units for statistics NUT level 2 (basic regions for the application of regional policies) under cropland land use, and the scenario analysis has found potential non-conflictual land where this is profitable to establish cereal-oil crops rotations for food and energy purposes. The objective of the BIO4A project, funded by the EU's Horizon2020 programme, is to support the implementation of sustainable feedstock production for biofuels in EU marginal land. We applied spatial multi-criteria decision analysis techniques in geographic information systems to generate a land suitability maps at 500-m spatial resolution, biophysical assessment (considering the topography, topsoil SOC and average precipitations) producing a classification of land suitability with the following classes, Crops Suitability:

- Very high (>75%)
- High (60% - 80%)
- Moderate (40% - 60%)
- Low (20% - 40%)
- Very low (<20%)

GIS mapping of potential of Camelina feedstock production on marginal lands in EU MED area identifies the potential suitable areas based on the current CORINE (CLC) land cover classes with three possible scenarios assessing the potential of:

- present cultivated with fields rainfed (CLC 211),
- suitable land covers that might contain rainfed crops and marginal underutilised land (CLC 241,242,243),
- total area for the cultivation which contains rainfed cropland marginal underutilised land (CLC 211,241,242,243,).

The Environmental sustainability of feedstock potential production on marginal land is assessed through the application of the convergence of evidence methodology and a set of environmental sustainability indicators:

- Soil Erosion
- Soil Pollution
- Soil Nutrient
- Soil Salinization
- Soil Compaction
- Soil Sealing

While agricultural soils are important everywhere, the analysis helps identify the places that are among the most critical for local communities, and nearby potential. There is a need for sustainable no-food-competing feedstock for HEFA production: in this respect, the EC REDII Directive has indicated a possible route in so-called low-ILUC biofuels[1]. This option will mostly mean exploiting marginal lands with new drought-resistant no-food or dedicated crops, so to develop a long-term strategy that increases soil resilience towards climate change and desertification.

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1 **Consolidated text: Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) (Text with EEA relevance).**

This is particularly true in Southern Mediterranean region, where strong evidence exist of land degradation effects, as depicted in the latest JRC assessment on land degradation using the SDG 15.3.1 in the EU (Schillaci et al., 2022). Under these circumstances, changes of land cover, loss in vegetation productivity, loss of soil organic carbon in triggering consequences that in extreme cases will bring to desertification.

In Mediterranean climates, wood encroachment will replace agricultural land due to the unfavorable climatic conditions JRC led the land degradation (LD) assessment study based on the UN SDG 15.3.1 indicator at EU27 scale using the high-resolution land productivity, land cover and SOC stock changes. Results indicate that EU27 land evidence degradation trends in 23% of the area, followed by 69% under stable condition, and 7% of the area with improving conditions. The SDG 15.3.1 indicator can recognize a part of the ongoing potential LD issues but not always capture the severely degraded land. There is need to take action before further land is irreversibly lost, in particular in Spain, Portugal, Italy and Greece, as well as in the Southern rim of the Mediterranean basin

BIO4A developed a strategy for the valorization of drought resistant crops in marginal lands of Southern EU. The action is composed by three main pillars: 1) the use of organic amendments such as compost from biomass Anaerobic Digestion sludge; 2) the use of biochar (since the initial composting phase) obtained by the pyrolysis of agricultural/forest residues to increase soil resilience to climate change; and 3) the cultivation of selected varieties of drought resistance oil crops (e.g. Camelina Sativa L. Cranz) suitable for aviation fuel production.

This approach, has never been tested in the Aviation biofuel chain in Southern EU/MED soils, and is fully in line with the proposed EC R Directive 2018/2001 (REDII), the Sustainable Development Goal (SDGs) targets on land degradation and climate change mitigation, and the EU's roadmap to a Resource Efficient Europe which aims at no net land take by 2050. Moreover, if successful, this approach can be replicated in many EU areas and other parts of the world experiencing the same conditions due to climate change.

The amount of marginal land in the EU28 was estimated at 18.3 Million of ha by the EU project S2Biom. In addition to the production of sustainable lipids for Aviation, the proposed solutions will also sequester C from the atmosphere, as biochar is mainly fixed carbon that will remain in the soil for hundreds' years: this is in full line with the Paris COP21 indication to develop Carbon Negative actions and not just Carbon Neutral ones.

General objectives of the project

Decarbonizing & reducing aviation dependence on fossil fuel requires biofuels. Considering that, the steady grow of the aviation industry and the aim of reducing the emission by 50% in 2050 is becoming indispensable to find viable solution such as the adoption of Sustainable Alternative Fuels (SAF) (Panoutsou et al., 2021). However, today SAF are available only in rather small amounts compared to the jet fuel demand. It is therefore vital to scale up commercial production in Europe (Chiaramonti and Panoutsou, 2019). Furthermore, the scalability of the HEFA pathway (the main commercial pathway as of today) is limited, due to constrained availability of truly sustainable feedstock sources. Bio4A therefore defined two main objectives for the action:

1. Increase EU installed capacity and supply, and prove SAF production on commercial scale in Europe with residual lipids

2. Develop Low-ILUC feedstock strategies to increase the potential supply of EU sustainable lipids to HEFA pathway

Bio4A is also developing a R&D strategy for low-ILUC biofuels in marginal lands of Southern EU, composed by three main complementary pillars: (1) use of compost, (2) use of biochar as a Negative Emission Technology, and (3) cultivation of selected varieties of drought resistant oil crops suitable for aviation fuel production, such as Camelina sativa. The proposed solutions will also sequester C from the atmosphere, as biochar is mainly fixed and recalcitrant C that will remain in the soil for hundreds' years: this is in full line with the Paris COP21 indication to develop Carbon Negative actions. The use of LCA will allow evaluating SAF chain in order to prove greenhouse gases emissions reduction compared to fossil Jet A1 of at least 60%. Expected social impacts will be assessed for human and labor rights, rural and social development, number of jobs created, among others.

2. GIS Biophysical constraints identification for rainfed crop cultivation in the Mediterranean area

2. Land suitability assessment

The land potential for oil crops production can be determined by an evaluation of the main biophysical factors such as topography, climate, soils and management as well as economic factors (farm distance to transportation networks and Refineries and Processing plants, agricultural mechanization, crop rotation, irrigation, ecosystem services). Consistently with the scale of investigation, logistic aspects of the post-harvest are not taken into account. The BIOPLAT-EU project provided web-GIS to map suitable marginal and underutized contaminated lands for sustainable oil crop production at pan-European level where refineries and biomass conversion plans are available to calculate the logistic aspects. The objective of BIO4A project takes into account the future need to SAF supply for the aviation sector. The scenario adopted consider the steadily production of feedstock with the cultivation of Camelina (Camelina sativa L. Cranz) in rotation with Barley. A Multi-Criteria Decision Analysis (MCDA) in a GIS framework that provides soil, land cover, terrain and climate traits was adopted to define the overall suitability at a 500m pixel scale in Southern European regions. The MCDA adopted for support decision-makers analyse a set of alternative indicators and uses decision rules to aggregate the criteria, which allows the alternative solutions to be ranked or prioritized. The MCDA provided a general framework to operate a suitability mapping by relating previously unrelated agro-ecological parameters. It consisted in the definition of an area based on climate pattern, previously cultivated agricultural land cover (CORINE), soil texture, fertility (SOC percentage based on LUCAS soil survey) and soil bulk density. Topographic features (slope and aspect) were also taken into account to define the main local condition for the crop modelling scenarios (Figure 1).

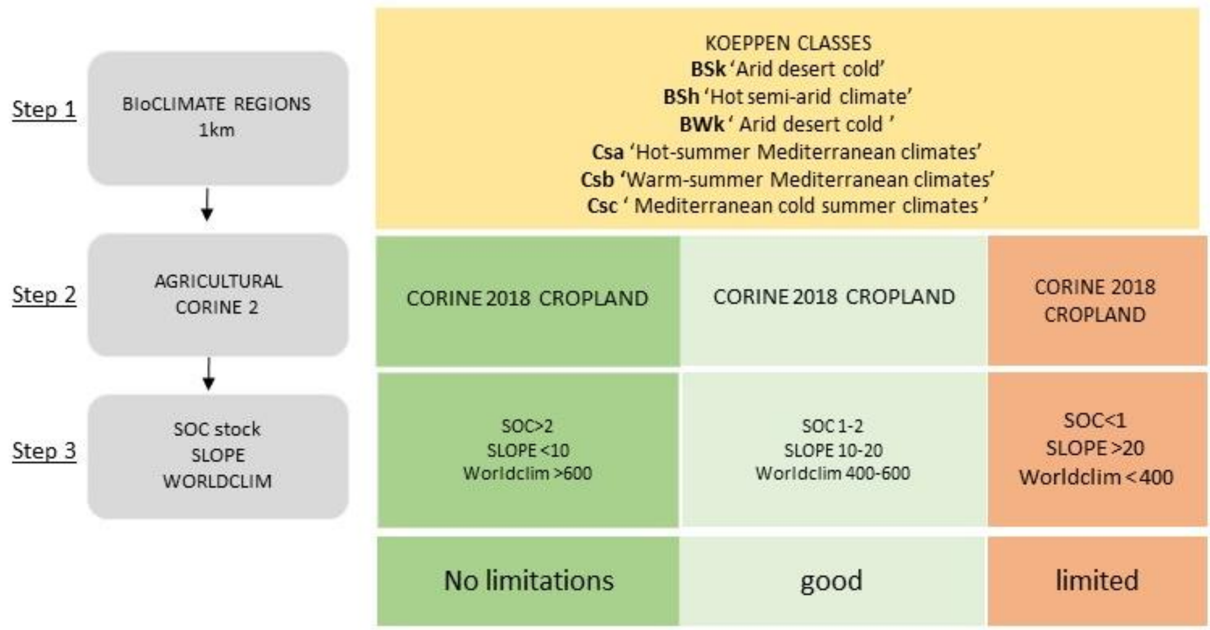


Figure 1 Climate, land cover and biophysical parameters taken into account to define the study area.

2.1 Climate classification - Köppen climate zones

The Köppen-Geiger climate classification (Chen and Chen, 2013; Rubel and Kottek, 2010) was developed based on the empirical relationship between climate and vegetation. This climate classification scheme provides an efficient way to describe climatic conditions defined by multiple variables and their seasonality with a single metric. This classification is used in ecological modelling and for agronomy purposes, to define homogeneous zones for both conservation and management. Many examples of its use can be found in literature for mapping geographic distribution of long-term mean climate and associated ecosystem conditions. Recently, there was an increasing interest in using the classification to identify changes in climate and potential changes in vegetation over time. This work used a Köppen dataset developed by (Beck et al., 2018) to reveal potential semi-arid areas for Camelina production in the Mediterranean Region of the EU and other European countries. The most widespread class is the dry climate (B) in which the controlling factor on vegetation is dryness, which is defined by the relationship between the precipitation input to the soil in which the plants grow and the evaporative losses. Since evaporation is difficult to evaluate and is not a conventional measurement, aridity is defined in terms of a temperature-precipitation index. To meet these conditions the total annual precipitation is less than 10 times the dryness threshold accompanied by a significant areal of Mild temperate, with a coldest month temperature greater than -3 °C and less than +18 °C climate (E) since the 1980s, which have practical and theoretical implication.

In particular three classes of dry climates were identified as suitable:

- **Bwk** Total annual precipitation is less than or equal to 5 times the dryness threshold. Annual mean temperature less than +18 °C (i.e. generally cold, dry winters).
- **Bsh** (semi-arid) which has a total annual precipitation is greater than 5 times the dryness threshold annual mean temperature is greater than or equal to +18 °C (i.e. hot, dry summers and cool, humid winters).
- **Bsk** (semi-arid) which has a total annual precipitation greater than 5 times the dryness threshold. Annual mean temperature is less than +18 ° (often found bordering Bsh, with warm, dry summers and cold, humid winters).

In addition, we also find occurrences of dry temperate climates (C), with two classes of interest:

- **Csa**, Mild temperate with dry summer, driest month precipitation in summer is less than driest month in winter, wettest month precipitation in winter is more than 3 times the driest month precipitation in summer, and driest month precipitation in summer is less than 40 mm, Warmest month temperature is greater than or equal to +22 °C.
- **Csb**, Mild temperate with dry summer, coldest month averaging above 0 °C (32 °F) (or −3 °C (27 °F)), all months with average temperatures below 22 °C (71.6 °F), and at least four months averaging above 10 °C (50 °F). At least three times as much precipitation in the wettest month of winter as in the driest month of summer, and driest month of summer receives less than 40 mm (1.6 in).
- **Cfa**, Different from Cs and Cw, can be defined as mild temperate, fully humid. Warmest monthly temperature is greater than or equal to +22 °C

2.2 CORINE Land cover

Traditionally, human activity has shaped our landscape, with an impact on the environment. Natural capital entail, land resource used for multiple purposes: agriculture, mining, manufacturing and construction, transport and residential use. The effects of overexploitation have changed natural vegetation to cropland and pastures, and sometimes the signs of desertification are visible in certain EU regions [3]. Global warming has contributed towards increasing awareness and recognition that land provides many ecosystem services, and it is a limited resource. The Corine land cover (CLC) is a pan-European inventory of land cover coordinated by the European Environment Agency. It provides a biophysical classification of artificial areas, agricultural areas, forests and semi-natural areas, wetland and water bodies. In this work, the dataset for 2018 is used to select all the agricultural areas that could be suitable for the production of Camelina. This layer is made up of several classes, including rainfed cropland (Corine code 211), fruit and trees (Corine code 223) and complex agricultural patterns (Corine code 241), where the interpretation of the spectral information denoted a mixture of agriculture and natural vegetation. A high proportion of the EU's territory, 40%, is used for agriculture (EUROSTAT, 2021).

2.3 LUCAS Soil data, texture, Soil organic Carbon and Bulk Density

The Land Use and Coverage Area frame Survey (LUCAS) has collected statistical information on land use and land cover over the territory of the EU from 2006. In 2009, a Soil Component (LUCAS Soil) was added. The soil sampling follows a complicated sample design, based on the random stratified sample of the field verification points of the main survey. Soil samples and supporting data were collected by direct observations of about 22,000 points (a similar number were also collected by the 2015 LUCAS survey) by surveyors on the ground (in situ). The initial objective for the LUCAS Soil survey was to collect data on soil organic carbon (SOC), with emphasis on agricultural soils. Over time the scope of the LUCAS Soil survey was broadened and additional parameters were collected and analysed. For the chemical and physical laboratory analysis, composite sample of approximately 500 g are taken from five subsamples collected with a spade at each LUCAS point. The first subsample is used to report the location coordinates, the other four subsamples were collected at a distance of 2 m following the cardinal directions (North, East, South and West). In the exact place of sampling, stones (>6 cm) (FAO, 2006), plant residues, grass and litter were removed from soil surface by raking with the spade. The five subsamples in the bucket were mixed with a trowel. Aliquots (about 500 g) of the mixed soil are taken with a trowel from the bucket, placed in a plastic bag, and labelled to derive the composite sample. Soil samples were allowed to air dry before the bags were sealed. Based on the 2009 data, topsoil texture has been mapped for the EU, (EU 26) with a nominal pixel resolution of 500x500 m (Ballabio et al., 2019). These data are available for the yield model simulation. Furthermore, soil organic carbon data are available from both the 2009 and the 2015 sampling campaign and spatially available at the same resolution of the fine earth fraction (Ballabio et al., 2016). Relatively high values of BD indicate soil compaction which may lead to reduced water infiltration especially in agricultural land, where it can hamper the growth of crop root systems (Schillaci et al., 2021). Soil Bulk Density (BD) is calculated as the dry weight of soil divided by its volume. Volumes include soil particle volume and pore space between soil particles. Soil BD is typically expressed in g cm^{-3} or Mg m^{-3} (SI). BD is necessary to calculate SOC stocks and is directly linked to soil functionality including mechanical support of crop plants, circulation of soil solution, and soil aeration. In LUCAS soil BD values are derived from packing density data using the equation proposed by (Jones et al., 2003) conditioned by clay content and quantify the meaning of qualitative categories of packing density for mineral soils.

2.4 Topography

Due to the scale of the analysis, the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) with an original resolution of 30 m (Farr et al., 2007), was resampled to 500 meters. This information was used to calculate the additional geomorphometric derivatives of slope and aspect, (using SAGA GIS, Conrad et al., 2015). The derived slope map was reclassified in two classes: slope from 0-15% and >15%. Aspect was reclassified into North (315-45 degrees), East (45-135 degrees), South (135-225), West (225-315).

2.5 Map of the biophysical constraints identification for land suitability assessmen

The map of the biophysical constraints is representing a generalized model of land suitability based on environmental factors. Values were assigned to the Slope (1= >15%, 2= <15%,3= 0 %), Soil organic Carbon (1 <1% , 2 1-2.5%, and 3 >2.5%), average annual rainfall taken from WorldClim Bio12 (1<400 mm yr^{-1} , 2

400-700 mm yr^{-1}, and 3 >800 mm yr^{-1}), overlaid in GIS at 500 m pixel scale. The results for the suitability, presented at pixel scale.

Previously published reports have described biophysical limitation, morphological and climatic suitability, as key elements to consider when evaluating productivity level (yield) for the production of food, feed and energy. The highest overall suitability will possibly reduce the application of mineral fertilizers input which is extremely important for the production of biomass for energy purposes, Biochar and Compost amendments can offset C losses in sites where the model showed losses due to the cultivation. It is therefore of particular interest to evaluate, at local scale NUTS 2 level, the land resources necessary to support the production of land-based energy sources and the provision of other services, as demanded by the upstream economic and energy models.

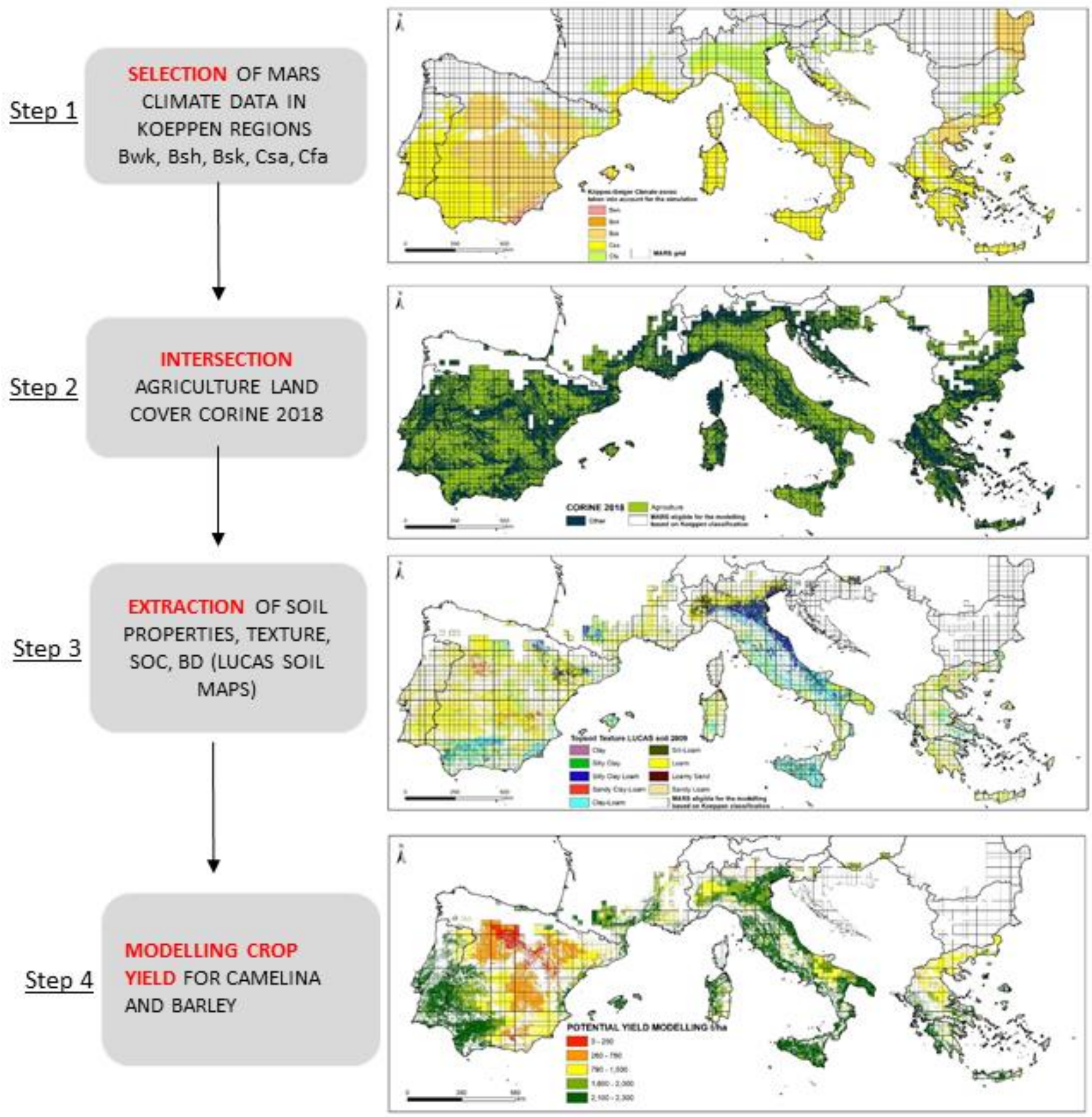


Figure 2 Conceptual diagram showing the four steps performed prior to the simulation using ARMOSA crop model.

The Köppen climatic regions offer a long-term condition of biophysical conditions throughout the seasons. In the step 2, land cover defined the study area inside the climatic region; LUCAS soil properties provided the physical properties and the initial fertility conditions upon which the model calculated the dynamics due to the cultivation.

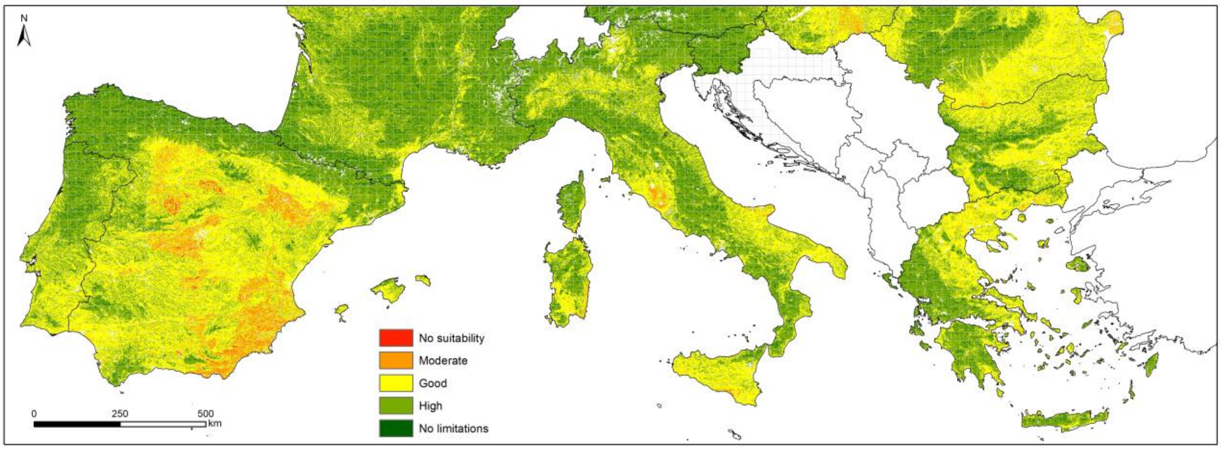


Figure 3 Multi-Criteria Decision Analysis (MCDA) based on biophysical variables.

3. GIS metadata and online repository compilation

3.1 INSPIRE metadata form

3.2 Data availability via the European Soil Data Centre ESDAC

A GIS data from the modeling exercise carried out for Camelina in rotation with Barley are made available along with metadata in the Zenodo platform and after the publication of the peer review paper in the European Soil Data Centre ESDAC webpage

4. GIS Camelina Yield modelling results and marginality assessment via yield thresholds

Cultivation of Bioenergy crops has the potential to release or capture Carbon Dioxide (Atmospheric CO_2) as a consequence of land-use changes (LUC). These events are caused by the exchange of biomass, soil and organic waste contained on and within the land. In some cases, these emissions may dominate the GHG life cycle of the biofuel route. According with Plevin at al., (2010), The land-use changes can be divided into i) direct land-use change (dLUC), referring to the change of land of natural vegetation to agriculture, or from a specific cultivation to another one causing a change in the capacity of the land; and ii) indirect land-use change (iLUC), referring to the change of land produced by the cultivation of certain biomass, that is, outside the boundary of the system being assessed also known as the "butterfly effect" (Escalante et al., 2022). This usually occurs when dLUC replaces a raw material already on the market, so an attempt is made to make up for the deficit. The magnitude of the emissions generated by the LUC will depend on the type of land converted into a cultivation field and the type of seed to be cultivated. dLUC also involves the conversion of land for the construction or conversion of biorefineries for the production of biofuels.

The Camelina seed yield is the main source of supply, which is determined by the area harvested (acreage) and yield per hectare. The cultivated area with oil crops, which generally reflects the net return to farmers who grow food, was experienced a rising in the EU during 1990s and 2020s[2] but to avoid competition with the food crops is becoming imminent and land is approaching the maximum capacity (Gelfand et al., 2013). Factors such as climate and weather conditions mainly affect agricultural yields (Bregaglio et al., 2014; Filippi et al., 2019; Masselink et al., 2016). Higher temperatures may not only reduce the time farmers spend in the field (Zhao et al., 2021), but may also cut down grain yields owing to water shortages and higher evaporation rates (Dumortier et al., 2021). Apart from this, for heatwaves (Fabri et al., 2022) noted that this factor may not affect farmer as well as average warming. Temperature and precipitation as easily obtainable weather factors are often available at coarse spatial scale (10 to 100 km) for the continental scale. The use downscaled meteorological data to estimate yields in most cases result in no statistical differences from observations and therefore average simulated yield derived from downscaled data are suitable for regional scale mapping (Cammarano et al., 2013). The identification of potentially suitable lands for Camelina production was undertaken based on the integration and analysis of different spatially explicit factors compiled in a GIS environment. The spatial suitability analysis was derived from the crop modelling results (Schillaci et al., submitted) from: i) the simulations values achieved by calibrating the ARMOSA crop model were obtained by real field experiments retrieved in published peer review papers; ii) the meteorological daily data from the Gridded Agro-Meteorological Data in Europe; selected soil traits derived from LUCAS soil module (Soil organic carbon and soil texture) and environmental factors such as Slope and Aspect.

Marginality was recently framed as a dynamic concept in time and space (Csikós and Tóth, 2023). The changing meaning of Marginal land can be managed by choosing the right agronomic technique and conservation agriculture practices that can transform marginal land into an optimal soil condition or incorrect management can degrade prime land into marginal land.

[2] (https://agridata.ec.europa.eu/extensions/DashboardCereals/OilseedProduction.html

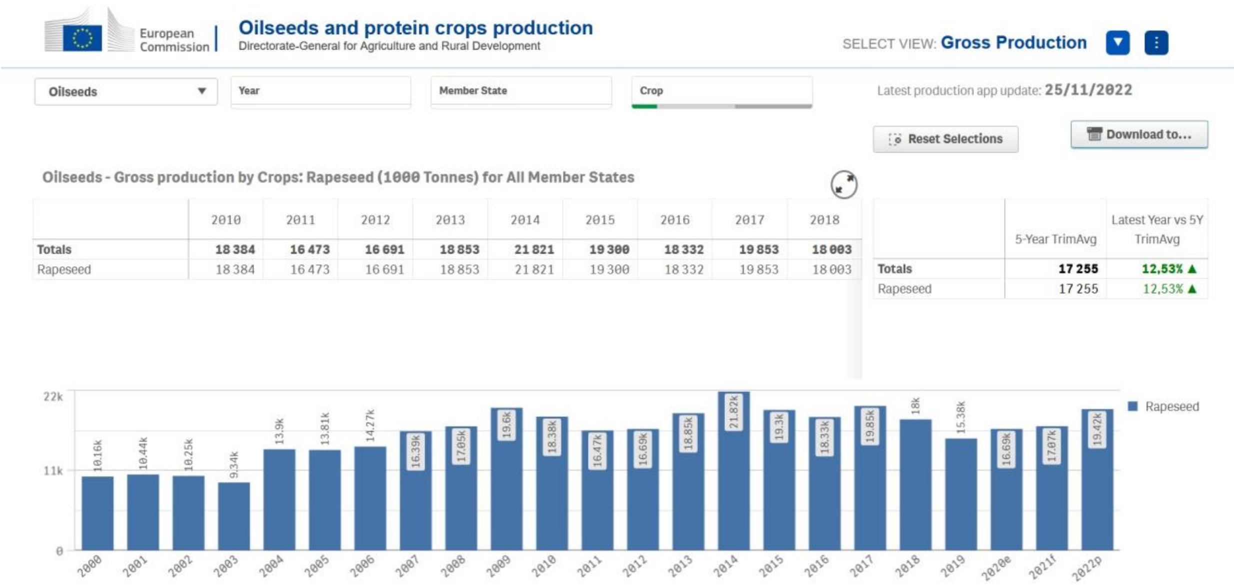


Figure 4 Oilseed and protein crops production

The Eurostat reports the total area and gross production in (tonnes) for the main oilseed crop cultivated in the EU (Figure 4).

4.1 Scenario current rainfed cropland based on CLC 2018 class 211

Figure 5 reports the scenario obtained on CLC classes 211, the modelling procedures is described in Deliverable D2.7 [Assessment of potential for drought-resistant oil crop in marginal land of Southern Europe and abroad].

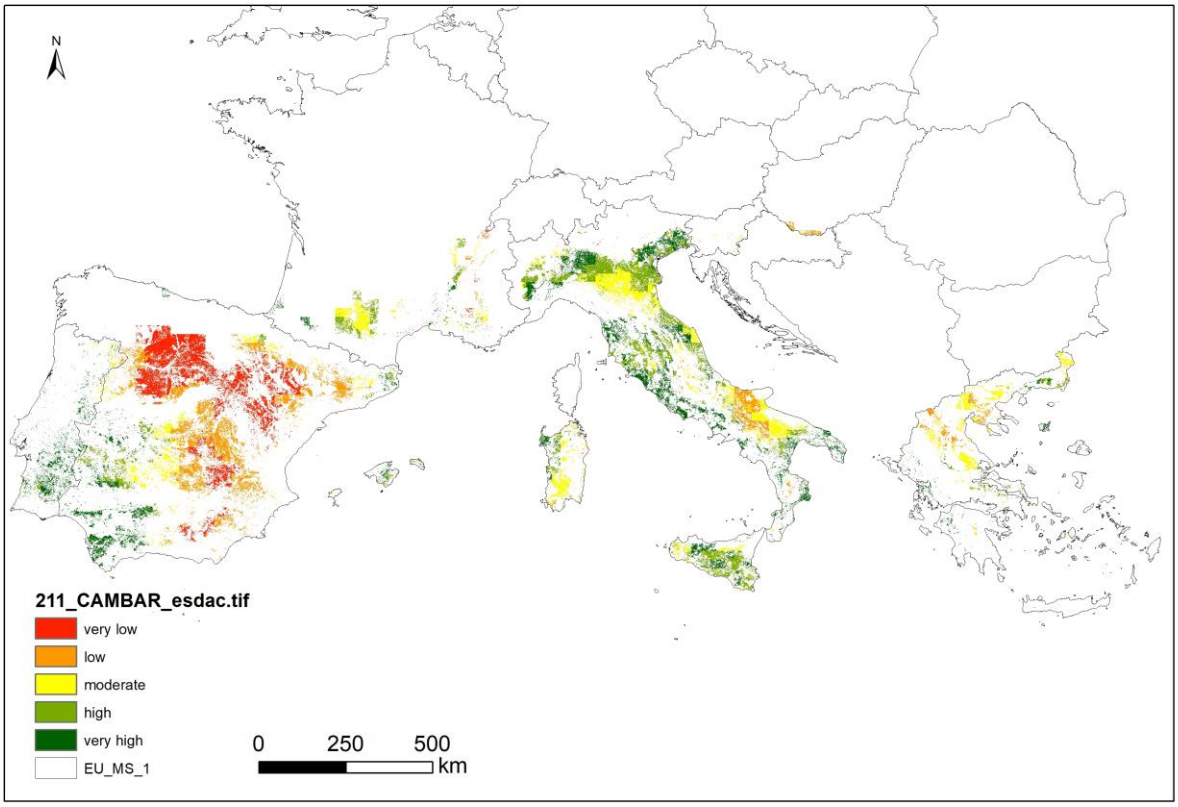
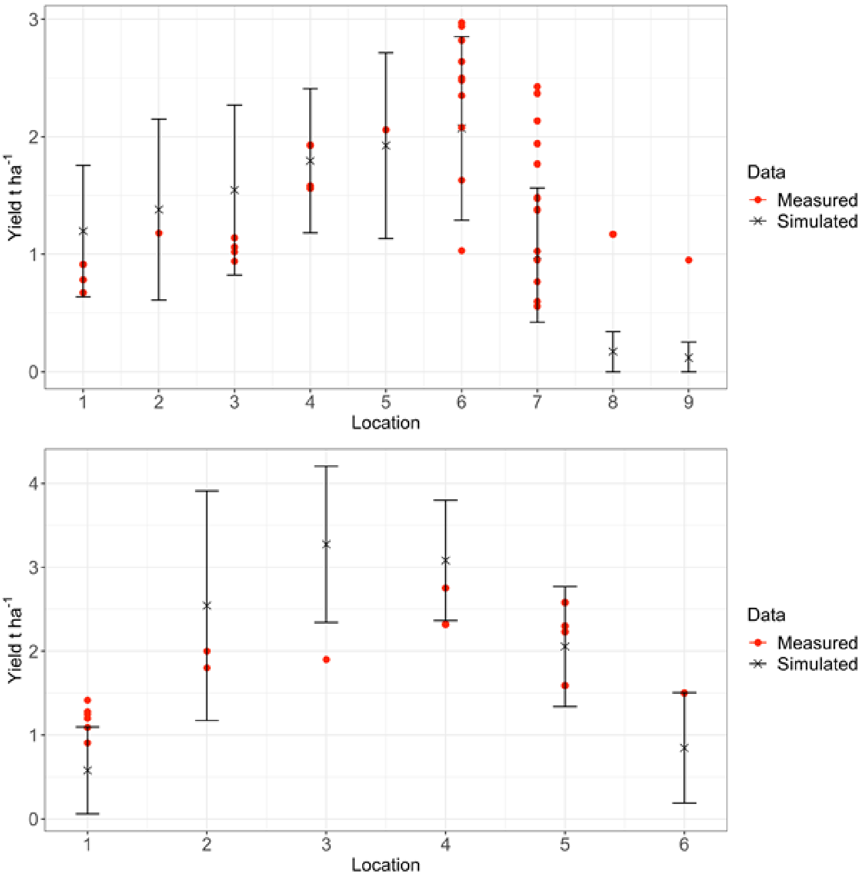


Figure 5 Scenario current rainfed cropland based on CLC 2018 class 211

Header		
Filename	211_CAMBAR_esdac.tif	
Published name	ESDAC_EUSO	
Data flow ID	CAMELINA_BARLEY_EUMED	
Data flow version	1.0	
Organization code	4D0	
Time dimension	2022-A0	
For publication	YES	
Data set action		
Concepts		
Concept name	**Concept value**	**Restricted from publication**
1. Contact		NO
1.1. Contact organisation	JRC, ESDAC, European Soil Data Centre	NO

1.2. Contact organisation unit	E2: Crop models; sustainable development	NO
1.3. Contact name	Calogero Schillaci, Arwyn Jones	YES
1.4. Contact person function	Restricted from publication	YES
1.5. Contact mail address	e-mail contact: mailto:esdac@ec.europa.eu">ESDAC@ec.europa.eu	NO
1.6. Contact email address	Restricted from publication	YES
1.7. Contact phone number	Restricted from publication	YES
1.8. Contact fax number	Restricted from publication	YES
2. Metadata update		NO
2.1. Metadata last certified	11/30/2022	NO
2.2. Metadata last posted	11/30/2022	NO
2.3. Metadata last update	11/30/2022	NO
3. Relevance	The Camelina yield in current rainfed agricultural land CLC 211-2018; is part of the BIO4A project deliverables. It is used to estimate the potential amount of feedstock that can be produced in the selected Koeppen bioclimates (Bwk, Bsh, Bsk, Csa, Csb, Cfa) and promoting sustainable use of land which is embedded in the European Commission's Priorities under the European Green Deal and the Renewable Energy Directive. This conservative scenario is considering the potential cultivation of Camelina in rotation with Barley in agricultural land that can benefit from crop diversification.	NO
4. Statistical Indicator		NO

4.1. Data description	The model estimates the yields year by year averaged in the 20 years period. This provides an indication of the stable economically feasible regions (regions with an yield > 1.4 t ha^{-1}), which occurs when agricultural area cultivated with Camelina in rotation with Barley has produced in average 1.4 t ha^{-1}. The map builds on data from: • Köppen climates (Beck et al., 2018) • MARS Gridded Agro-Meteorological Data in Europe (https://agri4cast.jrc.ec.europa.eu/dataportal/) • Digital elevation model (SRTM) for derivation of SLOPE and ASPECT (open topography) LUCAS soil organic carbon and texture maps (Ballabio et al., 2016) •	NO
4.2. Unit of measure	t ha^{-1}	NO
4.3. Reference Period	Average yield 2000-2020	NO
4.4. Accuracy - overall	The ARMOSA model was calibrated using published field trials results having in their framework a set of parameters such as, date of sowing, tillage, fertilization, irrigation. The average yield results are reflecting the interplay among the weather, biophysical characteristics of the land especially SOC and BD. This implies that trade-offs between the use of Camelina as energy crop in the optimal locations and as cover crop in the less favourable regions where only in optimal years can reach an economical sustainable yield. References for Camelina cultivation in Europe and in semi-arid climate under open field condition in the study area are limited. The average yield for all the data found in the literature for all sowing time and genotype was 1500 ± 700 kg ha–1. With regard to the potential Camelina yield, our results were similar to those obtained in the field experiments in Southern European countries. Results of the calibration showed good accordance between observed and simulated value.	NO



Yields data, calibration in the upper panel with 9 sites, and validation set in the lower panel with 6 sites.

Data used for the ARMOSA model calibration and validation.

ID	Publication	Year of cultivation	Country
1	(Angelopoulou et al., 2020)	2020	Greece
2	(Zanetti et al., 2020)	2017	Greece
3	(Matteo et al., 2020)	2020	Italy
4	(Masella et al., 2014)	2014	Italy
5	(Cappelli et al., 2019)	2019	Italy
6	(Royo-Esnal and Valencia-Gredilla, 2018).	2018	Spain
7	(Royo-Esnal and Valencia-Gredilla, 2018)	2017	Spain
8	(Stefanoni et al., 2020)	2020	Spain
9	(Stefanoni et al., 2020)	2020	Spain

	1 (Martinez et al., 2021) 2021 Spain validation 2 (Avola et al., 2021) 2021 Italy validation 3 (Angelini et al., 2021) 2020 Italy validation 4 (Tedone et al., 2022) 2020 Italy validation 5 (Righini et al., 2019) 2019 Italy validation 6 Camelina España Company (Bio4A partner) 2019 Spain validation Based on the potential yield obtained from ARMOSA model at NUTS 2 level over the time period 2000-2020, we can define marginal lands using as a threshold at NUTS 2 level the average yield found in the literature (1458 kg ha-1) the 21% (128,144 km2) of the 69 NUTS 2 suitable for Camelina cultivation. The remaining 79% (372,230 km2) performed above the average found in the literature.	
4.5. Source data		NO
4.5.1. Source data - Organisation	JRC	NO
4.5.2. Source data - Comment	Data source: https://xxx BIO4A H2020 project results Data provider JRC	NO
5. Frequency and Timeliness of dissemination		NO
5.1. Frequency of dissemination		NO
5.1.1. Frequency of dissemination - Grade	LOW	NO
5.1.2. Frequency of dissemination - Comment	Data are disseminated in 2022	NO
5.2. Timeliness		NO
5.2.1. Timeliness - Grade	LOW	NO
5.2.2. Timeliness - Comment	New data points are disseminated within three years after the reference year	NO
6. Coverage and comparability		NO
6.1. Reference area		NO
6.1.1. Reference Area - Grade	HIGH	NO

6.1.2. Reference Area - Comment	Southern EU Member States defined by Koeppen bioclimatic zones	NO
6.2. Comparability - geographical		NO
6.2.1. Comparability - geographical - Grade	HIGH	NO
6.2.2. Comparability - geographical - Comment	Data are comparable between other Modelling routine that uses the same input data and timespan	NO
6.3. Coverage - Time		NO
6.3.1. Time Coverage - Grade	HIGH	NO
6.3.2. Time Coverage - Comment	Simulated average from 2000-2020.	NO
6.4. Comparability - over time		NO
6.4.1. Comparability - over time - Grade	MEDIUM	NO
6.4.2. Comparability - over time - Comment	Data from 2000-2020 methodology.</p>	NO
7. Accessibility and clarity		NO
7.1. Dissemination format - Publications	Analysis of the data is presented in a scientific paper (Schillaci et al., in press)	NO
7.2. Dissemination format - online database	GIS data (.tiff maps at 500 m) and legends (optional legends .qml) https://xxx	NO
7.3. Dissemination format - other		NO
8. Comment	Copyright/Licence Policy	NO

Table x Metadata table Scenario 211

NUTS_ID	very low	low	moderate	high	very high	km2
ES12	0%	0%	0%	0%	100%	323.125
ES24	61%	37%	2%	0%	0%	27181.88
ES30	2%	81%	18%	0%	0%	3981.25
ES51	1%	63%	17%	10%	10%	9504.375
ES23	47%	53%	0%	0%	0%	691.25
CH01	100%	0%	0%	0%	0%	3.75
CH07	0%	0%	100%	0%	0%	1.25
BG42	1%	9%	90%	0%	0%	50

BG41	0%	23%	77%	0%	0%	18.75
ES53	0%	2%	4%	49%	44%	1805
PT11	0%	20%	41%	23%	17%	2146.875
ITG1	0%	0%	14%	58%	28%	21555.63
ES62	17%	83%	0%	0%	0%	3007.5
ES13	0%	0%	0%	0%	100%	2.5
ITG2	0%	7%	54%	27%	12%	13095
ES42	22%	61%	13%	4%	0%	63846.88
ES52	11%	70%	18%	0%	0%	1321.25
ES43	0%	0%	9%	50%	41%	13921.25
ES21	0%	45%	55%	0%	0%	247.5
ES41	84%	15%	1%	0%	0%	71632.5
ES11	0%	0%	0%	0%	100%	10
ES61	12%	12%	9%	8%	58%	23860
ES22	18%	43%	27%	12%	0%	5815.625
ITC1	0%	0%	12%	58%	30%	10273.13
HU23	3%	86%	12%	0%	0%	1739.375
PT18	0%	0%	0%	6%	94%	11353.13
HR02	0%	43%	57%	0%	0%	46.25
ITF1	0%	7%	33%	46%	15%	4581.25
ITF2	0%	41%	41%	16%	2%	4261.875
ITC4	1%	0%	18%	45%	36%	19775.63
ITF3	0%	40%	6%	7%	47%	7111.25
PT16	0%	0%	17%	4%	78%	2414.375
PT15	0%	0%	0%	13%	87%	208.75
PT17	0%	0%	0%	0%	100%	206.875
ITF4	0%	31%	45%	8%	16%	16807.5
ITF5	0%	25%	39%	21%	15%	9545
ITF6	0%	9%	3%	1%	87%	5100.625
ITC3	0%	9%	0%	0%	91%	156.875
AL03	0%	75%	0%	0%	25%	2.5
EL62	0%	0%	0%	0%	100%	82.5
EL63	0%	0%	0%	2%	98%	1267.5
EL41	0%	0%	0%	0%	100%	518.125
EL42	0%	41%	5%	4%	50%	441.25
EL51	0%	2%	49%	36%	13%	4695.625
ITI4	0%	1%	3%	13%	83%	12160
EL30	0%	0%	28%	72%	0%	124.375
EL61	0%	15%	74%	8%	3%	5163.125
EL65	0%	22%	39%	11%	27%	580
EL43	0%	5%	24%	23%	49%	79.375

EL52	0%	27%	73%	0%	0%	9270.625
ITH2	52%	48%	0%	0%	0%	14.375
ITH3	0%	0%	6%	63%	31%	16320
EL64	0%	1%	22%	69%	8%	2057.5
EL54	0%	0%	0%	8%	92%	434.375
ITH1	100%	0%	0%	0%	0%	9.375
EL53	0%	59%	41%	0%	0%	4509.375
FRL0	8%	13%	38%	36%	5%	3156.875
ITI3	0%	0%	24%	44%	32%	9868.125
FRJ1	0%	1%	49%	28%	22%	2101.875
FRI1	0%	0%	0%	0%	100%	1250.625
FRJ2	0%	1%	55%	43%	1%	14921.25
ITI2	0%	2%	8%	67%	23%	6086.875
ITI1	0%	0%	4%	45%	51%	12999.38
ITH5	0%	0%	67%	33%	0%	24063.13
SI04	0%	16%	68%	14%	2%	115
MK00	0%	68%	32%	0%	0%	21.25
ITH4	1%	0%	0%	29%	70%	4536.25
SI03	0%	32%	68%	0%	0%	290
FRK2	8%	16%	25%	40%	11%	4708.125
FRM0	0%	0%	0%	1%	99%	102.5
TR21	0%	0%	75%	25%	0%	10
HR06	0%	93%	7%	0%	0%	8.75
						499575

Table x potential yield in classes and total area per NUTS2.

4.2 Scenario current mixed land cover based on CLC 2018 classes 241,242,243

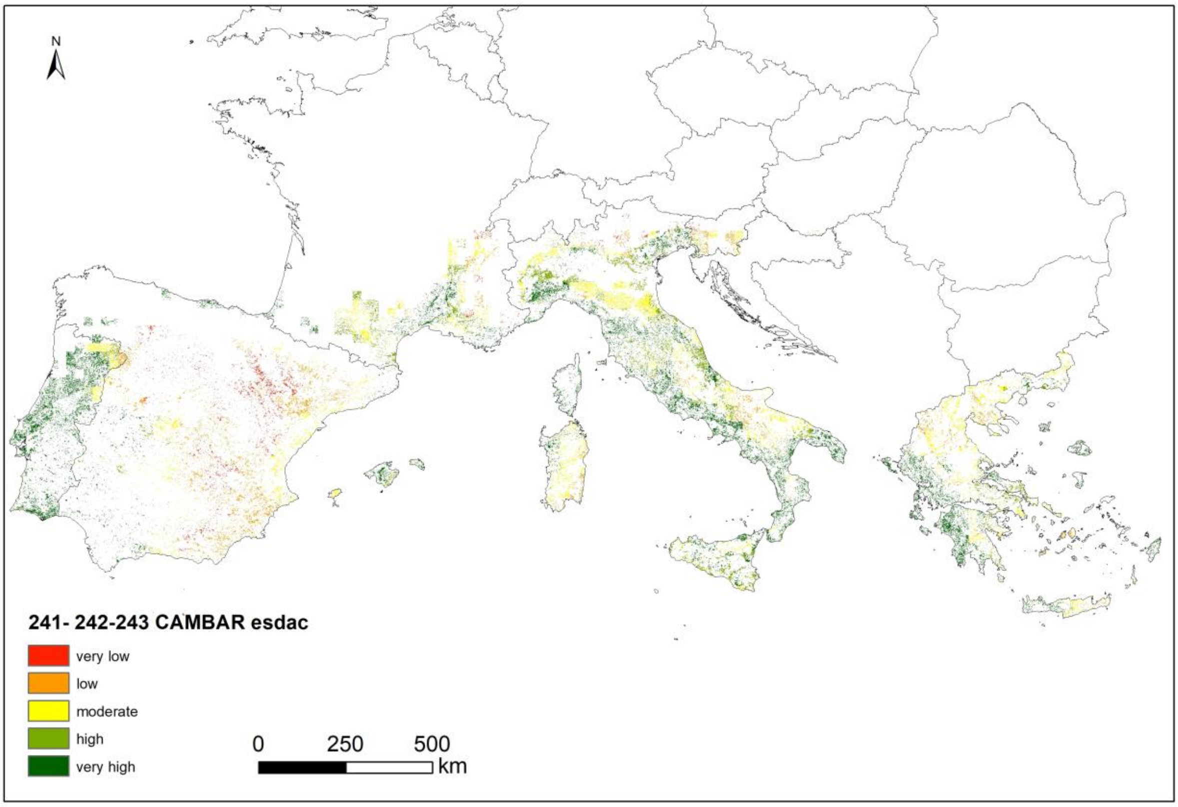


Figure 6 Scenario current mixed land cover based on CLC 2018 classes 241,242,243

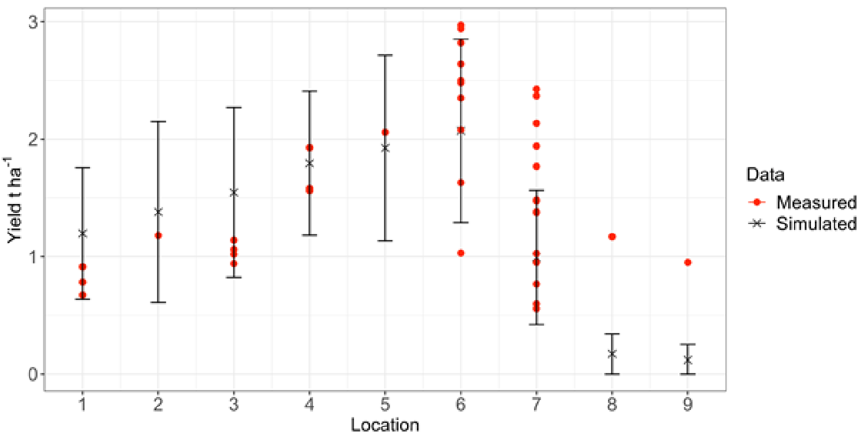
Figure 6reports the scenario obtained on CLC classes 241,242,243, the modelling procedures is described in Deliverable D2.7 [Assessment of potential for drought-resistant oil crop in marginal land of Southern Europe and abroad].

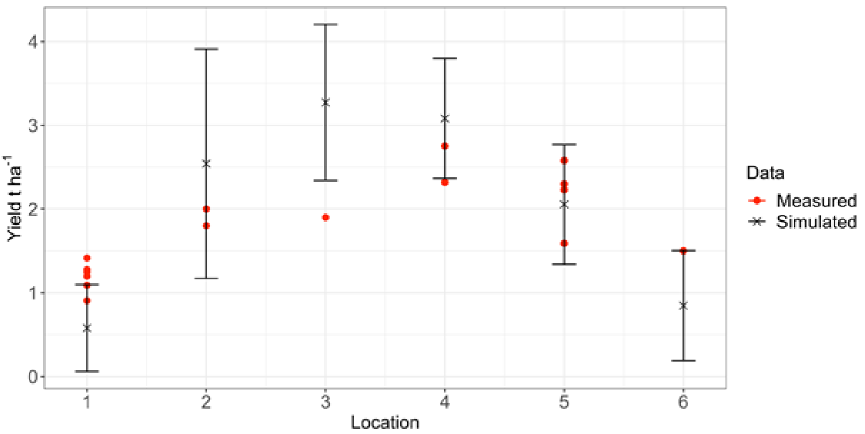
Header		
Filename	2414243_CAMBAR_esdac.tif	
Published name	ESDAC_EUSO	
Data flow ID	CAMELINA_BARLEY_EUMED	
Data flow version	1.0	
Organization code	4D0	
Time dimension	2022-A0	
For publication	YES	
Data set action		
Concepts		
Concept name	**Concept value**	**Restricted from publication**

1. Contact		NO
1.1. Contact organisation	JRC, ESDAC, European Soil Data Centre	NO
1.2. Contact organisation unit	E2: Crop models; sustainable development	NO
1.3. Contact name	Calogero Schillaci, Arwyn Jones	YES
1.4. Contact person function	Restricted from publication	YES
1.5. Contact mail address	e-mail contact: mailto:esdac@ec.europa.eu">ESDAC@ec.europa.eu	NO
1.6. Contact email address	Restricted from publication	YES
1.7. Contact phone number	Restricted from publication	YES
1.8. Contact fax number	Restricted from publication	YES
2. Metadata update		NO
2.1. Metadata last certified	11/30/2022	NO
2.2. Metadata last posted	11/30/2022	NO
2.3. Metadata last update	11/30/2022	NO
3. Relevance	The Camelina yield in current marginal and underutilized land CLC 241-242-243 from 2018; is part of the BIO4A project deliverables. It is used to estimate the potential amount of feedstock that can be produced in the selected Koeppen bioclimates (Bwk, Bsh, Bsk, Csa, Csb, Cfa) and promoting sustainable use of land which is embedded in the European Commission's Priorities under the European Green Deal and the Renewable Energy Directive. This conservative scenario is considering the potential cultivation of Camelina in rotation with Barley in agricultural land that can benefit from crop diversification.	NO
4. Statistical Indicator		NO
4.1. Data description	The model estimates the yieds year by year averaged in the 20 years period. This provides an indication of the stable economically feasible regions (regions with an yield > 1.4 t ha^{-1}), which occurs when agricultural area cultivated with Camelina in rotation with Barley has produced in average 1.4 t ha^{-1}. The map builds on data from: • Köppen climates (Beck et al., 2018) • MARS Gridded Agro-Meteorological Data in Europe (https://agri4cast.jrc.ec.europa.eu/dataportal/) • Digital elevation model (SRTM) for derivation of SLOPE and ASPECT (open topography) LUCAS soil organic carbon and texture maps (Ballabio et al., 2016) •	NO
4.2. Unit of measure	t ha^{-1}	NO
4.3. Reference Period	Average yield 2000-2020	NO

4.4. Accuracy - overall

The ARMOSA model was calibrated using published field trials results having in their framework a set of parameters such as, date of sowing, tillage, fertilization, irrigation. The average yield results are reflecting the interplay among the weather, biophysical characteristics of the land especially SOC and BD. This implies that trade-offs between the use of Camelina as energy crop in the optimal locations and as cover crop in the less favourable regions where only in optimal years can reach an economical sustainable yield. References for Camelina cultivation in Europe and in semi-arid climate under open field condition in the study area are limited. The average yield for all the data found in the literature for all sowing time and genotype was 1500 ± 700 kg ha^{-1}. With regard to the potential Camelina yield, our results were similar to those obtained in the field experiments in Southern European countries. Results of the calibration showed good accordance between observed and simulated value.





Yields data, calibration in the upper panel with 9 sites, and validation set in the lower panel with 6 sites.

Data used for the ARMOSA model calibration and validation.

ID	Publication	Year of	Country
1	(Angelopoulou et al., 2020)	2020	Greece

NO

2	(Zanetti et al., 2020)	2017	Greece	calibration
3	(Matteo et al., 2020)	2020	Italy	calibration
4	(Masella et al., 2014)	2014	Italy	calibration
5	(Cappelli et al., 2019)	2019	Italy	calibration
6	(Royo-Esnal and Valencia-	2018	Spain	calibration
7	(Royo-Esnal and Valencia-	2017	Spain	calibration
8	(Stefanoni et al., 2020)	2020	Spain	calibration
9	(Stefanoni et al., 2020)	2020	Spain	calibration
1	(Martinez et al., 2021)	2021	Spain	validation
2	(Avola et al., 2021)	2021	Italy	validation
3	(Angelini et al., 2021)	2020	Italy	validation
4	(Tedone et al., 2022)	2020	Italy	validation
5	(Righini et al., 2019)	2019	Italy	validation
6	Camelina España Company	2019	Spain	validation

Based on the potential yield obtained from ARMOSA model at NUTS 2 level over the time period 2000-2020, we can define marginal lands using as a threshold at NUTS 2 level the average yield found in the literature (1458 kg ha^{-1}) the 21% (128,144 km^2) of the 69 NUTS 2 suitable for Camelina cultivation. The remaining 79% (372,230 km^2) performed above the average found in the literature.

4.5. Source data		NO
4.5.1. Source data - Organisation	JRC	NO
4.5.2. Source data - Comment	Data source: https://xxx BIO4A H2020 project results Data provider JRC	NO
5. Frequency and Timeliness of dissemination		NO
5.1. Frequency of dissemination		NO
5.1.1. Frequency of dissemination - Grade	LOW	NO
5.1.2. Frequency of dissemination - Comment	Data are disseminated in 2022	NO
5.2. Timeliness		NO
5.2.1. Timeliness - Grade	LOW	NO
5.2.2. Timeliness - Comment	New data points are disseminated within three years after the reference year	NO
6. Coverage and comparability		NO
6.1. Reference area		NO

6.1.1. Reference Area - Grade	HIGH	NO
6.1.2. Reference Area - Comment	Southern EU Member States defined by Koeppen bioclimatic zones	NO
6.2. Comparability - geographical		NO
6.2.1. Comparability - geographical - Grade	HIGH	NO
6.2.2. Comparability - geographical - Comment	Data are comparable between other Modelling routine that uses the same input data and timespan	NO
6.3. Coverage - Time		NO
6.3.1. Time Coverage - Grade	HIGH	NO
6.3.2. Time Coverage - Comment	Simulated average from 2000-2020.	NO
6.4. Comparability - over time		NO
6.4.1. Comparability - over time - Grade	MEDIUM	NO
6.4.2. Comparability - over time - Comment	Data from 2000-2020 methodology.</p>	NO
7. Accessibility and clarity		NO
7.1. Dissemination format - Publications	Analysis of the data is presented in a scientific paper (Schillaci et al., in press)	NO
7.2. Dissemination format - online database	GIS data (.tiff maps at 500 m) and legends (optional legends .qml) https://xxx	NO
7.3. Dissemination format - other		NO
8. Comment	Copyright/Licence Policy	NO

Table x metadata table

NUTS_ID	very low	low	moderate	high	very high	km2
ES12	0%	0%	0%	0%	100%	330
ES24	48%	46%	6%	0%	0%	10756.25
ES30	1%	68%	30%	1%	0%	589.375
ES51	0%	49%	38%	6%	7%	3903.125
ES23	57%	43%	0%	0%	0%	488.75
CH07	0%	0%	100%	0%	0%	1.25

BG42	28%	2%	70%	0%	0%	26.875
BG41	0%	40%	60%	0%	0%	35.625
ES53	0%	1%	15%	31%	52%	2634.375
PT11	0%	8%	24%	14%	53%	10260
ITG1	0%	0%	13%	53%	34%	10306.88
ES62	4%	95%	1%	0%	0%	2951.25
ES13	0%	0%	0%	0%	100%	653.75
ITG2	1%	20%	50%	19%	11%	7876.875
ES42	20%	56%	18%	6%	0%	13593.75
ES52	4%	36%	57%	3%	0%	5617.5
ES43	0%	0%	4%	33%	63%	2878.75
ES21	0%	21%	6%	0%	74%	238.75
ES41	44%	44%	8%	2%	2%	5458.125
ES11	0%	0%	0%	0%	100%	1226.25
ES61	12%	39%	13%	5%	31%	7424.375
ES22	47%	33%	18%	2%	0%	485
ITC1	0%	2%	19%	42%	37%	10438.75
HU23	2%	94%	4%	0%	0%	135
PT18	0%	0%	0%	2%	97%	5811.25
HR03	12%	16%	10%	43%	18%	65.625
HR02	0%	19%	81%	0%	0%	99.375
ITF1	0%	6%	19%	51%	25%	5113.125
ITC2	0%	0%	100%	0%	0%	9.375
ITF2	0%	16%	38%	36%	10%	1980.625
ITC4	5%	13%	22%	35%	26%	3491.875
ITF3	0%	12%	7%	8%	73%	7547.5
PT16	0%	0%	7%	3%	90%	13771.88
PT15	0%	0%	0%	6%	94%	3183.75
PT17	0%	0%	0%	0%	100%	1662.5
ITF4	0%	12%	32%	16%	39%	7637.5
ITF5	0%	19%	21%	19%	42%	3439.375

ITF6	0%	2%	5%	2%	91%	6363.125
ITC3	0%	7%	0%	1%	91%	1641.875
AL03	0%	0%	0%	0%	100%	1.875
EL62	0%	0%	0%	0%	100%	1586.25
EL63	0%	0%	1%	2%	97%	5819.375
EL41	0%	0%	0%	0%	100%	1300
EL42	0%	42%	14%	0%	45%	1725
EL51	0%	4%	51%	27%	17%	3673.125
ITI4	0%	3%	3%	17%	77%	8248.125
EL30	0%	0%	40%	60%	0%	1296.875
EL61	0%	15%	42%	27%	15%	2960
EL65	0%	3%	21%	19%	57%	6665.625
EL43	0%	13%	28%	24%	34%	2660
EL52	0%	29%	71%	0%	0%	5841.875
ITH2	37%	62%	0%	0%	0%	678.125
ITH3	2%	6%	11%	51%	31%	6076.875
EL64	0%	5%	20%	57%	18%	4837.5
EL54	1%	2%	5%	5%	88%	3248.125
ITH1	91%	9%	0%	0%	0%	90
EL53	0%	53%	47%	0%	0%	2741.875
FRL0	6%	8%	20%	45%	21%	6194.375
ITI3	0%	0%	17%	55%	29%	4837.5
FRJ1	0%	4%	17%	35%	45%	6686.875
FRI1	0%	0%	0%	0%	100%	741.25
FRJ2	0%	3%	40%	51%	7%	7456.25
ITI2	0%	5%	11%	57%	27%	3522.5
ITI1	0%	0%	4%	32%	63%	7681.25
ITH5	0%	2%	73%	25%	0%	12550.63
SI04	10%	42%	28%	11%	9%	2021.25
MK00	0%	41%	59%	0%	0%	10.625

ITH4	3%	1%	1%	33%	61%	2216.25
SI03	1%	59%	40%	0%	0%	1951.25
FRK2	7%	14%	37%	22%	19%	7569.375
FRM0	0%	0%	1%	3%	96%	1491.875
TR21	0%	0%	100%	0%	0%	7.5
HR06	0%	38%	62%	0%	0%	34.375
						284553.1

Table x potential yield in classes and total area per NUTS2.

4.3 Scenario current rainfed cropland and mixed land cover classes 211,241,242,243

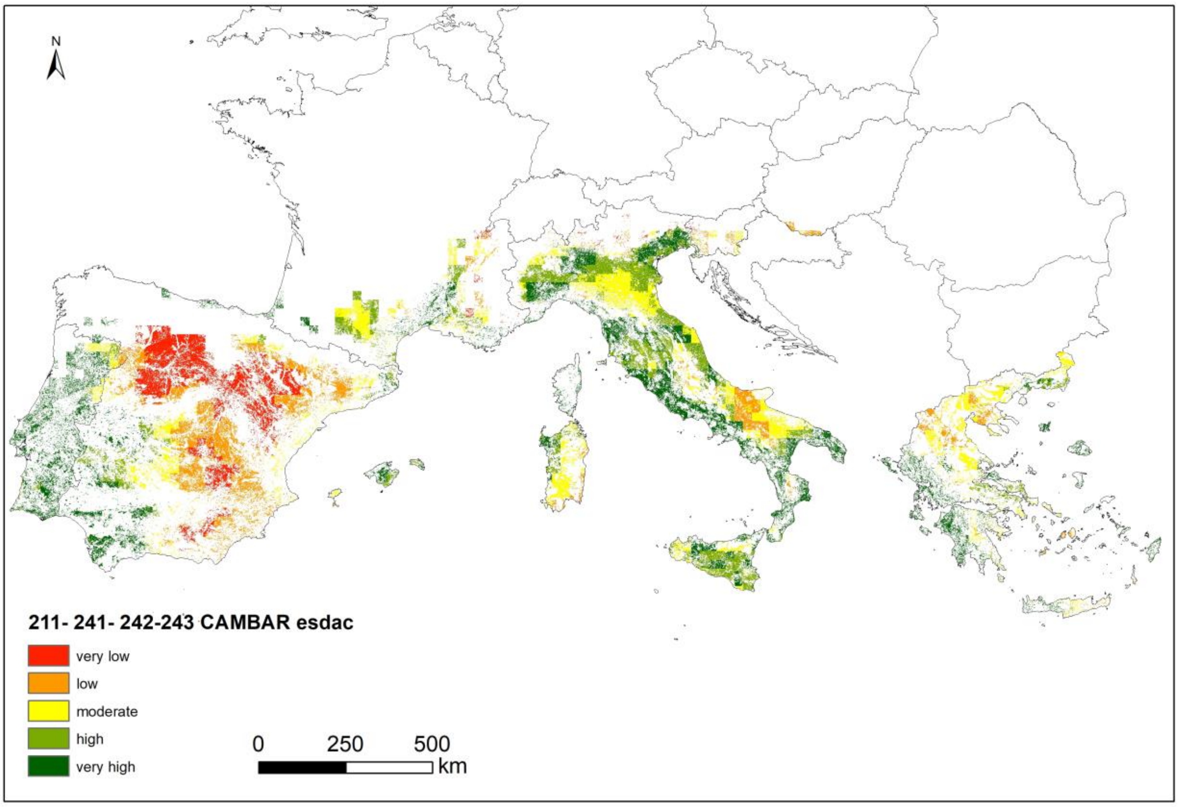
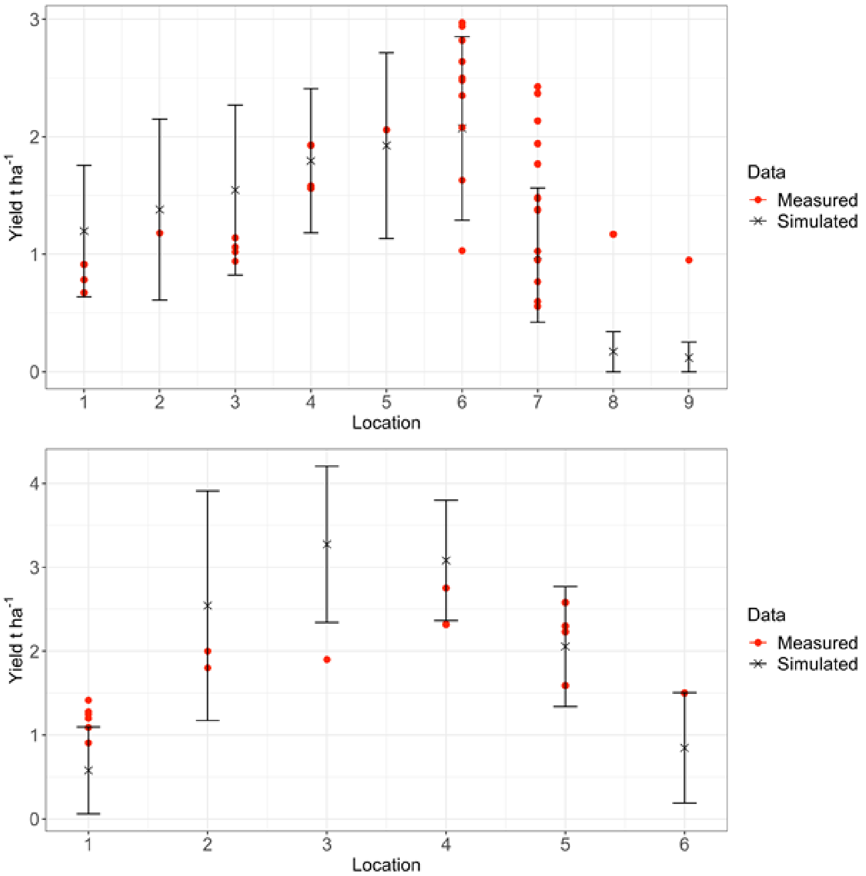


Figure 7 Scenario current rainfed cropland and mixed land cover classes 211,241,242,243

Figure 7reports the scenario obtained on CLC classes 211, 241, 242, 243, the modelling procedures is described in Deliverable D2.7 [Assessment of potential for drought-resistant oil crop in marginal land of Southern Europe and abroad].

Header		
Filename	211414243_CAMBAR_esdac.tif	
Published name	ESDAC_EUSO	
Data flow ID	CAMELINA_BARLEY_EUMED	
Data flow version	1.0	
Organization code	4D0	
Time dimension	2022-A0	
For publication	YES	
Data set action		
Concepts		
Concept name	**Concept value**	**Restricted from publication**
1. Contact		NO
1.1. Contact organisation	JRC, ESDAC, European Soil Data Centre	NO
1.2. Contact organisation unit	E2: Crop models; sustainable development	NO
1.3. Contact name	Calogero Schillaci, Arwyn Jones	YES
1.4. Contact person function	Restricted from publication	YES
1.5. Contact mail address	e-mail contact: mailto:esdac@ec.europa.eu">ESDAC@ec.europa.eu	NO
1.6. Contact email address	Restricted from publication	YES
1.7. Contact phone number	Restricted from publication	YES
1.8. Contact fax number	Restricted from publication	YES
2. Metadata update		NO
2.1. Metadata last certified	11/30/2022	NO
2.2. Metadata last posted	11/30/2022	NO
2.3. Metadata last update	11/30/2022	NO
3. Relevance	The Camelina yield in current rainfed agricultural land CLC 211 and marginal and underutilised land based on CORINE 2018; is part of the BIO4A project deliverables. It is used to estimate the potential amount of feedstock that can be produced in the selected Koeppen bioclimates (Bwk, Bsh, Bsk, Csa, Csb, Cfa) and promoting sustainable use of land which is embedded in the European Commission's Priorities under the European Green Deal and the Renewable Energy Directive. This conservative	NO

	scenario is considering the potential cultivation of Camelina in rotation with Barley in agricultural land that can benefit from crop diversification.	
4. Statistical Indicator		NO
4.1. Data description	The model estimates the yieds year by year averaged in the 20 years period. This provides an indication of the stable economically feasible regions (regions with an yield > 1.4 t ha^{-1}), which occurs when agricultural area cultivated with Camelina in rotation with Barley has produced in average 1.4 t ha^{-1}. The map builds on data from: • Köppen climates (Beck et al., 2018) • MARS Gridded Agro-Meteorological Data in Europe (https://agri4cast.jrc.ec.europa.eu/dataportal/) • Digital elevation model (SRTM) for derivation of SLOPE and ASPECT (open topography) LUCAS soil organic carbon and texture maps (Ballabio et al., 2016) •	NO
4.2. Unit of measure	t ha^{-1}	NO
4.3. Reference Period	Average yield 2000-2020	NO
4.4. Accuracy - overall	The ARMOSA model was calibrated using published field trials results having in their framework a set of parameters such as, date of sowing, tillage, fertilization, irrigation. The average yield results are reflecting the interplay among the weather, biophysical characteristics of the land especially SOC and BD. This implies that trade-offs between the use of Camelina as energy crop in the optimal locations and as cover crop in the less favourable regions where only in optimal years can reach an economical sustainable yield. References for Camelina cultivation in Europe and in semi-arid climate under open field condition in the study area are limited. The average yield for all the data found in the literature for all sowing time and genotype was 1500 ± 700 kg ha^{-1}. With regard to the potential Camelina yield, our results were similar to those obtained in the field experiments in Southern European countries. Results of the calibration showed good accordance between observed and simulated value.	NO



Yields data, calibration in the upper panel with 9 sites, and validation set in the lower panel with 6 sites.

Data used for the ARMOSA model calibration and validation.

ID	Publication	Year of cultivation	Country
1	(Angelopoulou et al., 2020)	2020	Greece
2	(Zanetti et al., 2020)	2017	Greece
3	(Matteo et al., 2020)	2020	Italy
4	(Masella et al., 2014)	2014	Italy
5	(Cappelli et al., 2019)	2019	Italy
6	(Royo-Esnal and Valencia-Gredilla, 2018)	2018	Spain
7	(Royo-Esnal and Valencia-Gredilla, 2018)	2017	Spain
8	(Stefanoni et al., 2020)	2020	Spain
9	(Stefanoni et al., 2020)	2020	Spain
1	(Martinez et al., 2021)	2021	Spain
2	(Avola et al., 2021)	2021	Italy
3	(Angelini et al., 2021)	2020	Italy
4	(Tedone et al., 2022)	2020	Italy
5	(Righini et al., 2019)	2019	Italy

	6 Camelina España Company 2019 Spain Based on the potential yield obtained from ARMOSA model at NUTS 2 level over the time period 2000-2020, we can define marginal lands using as a threshold at NUTS 2 level the average yield found in the literature (1458 kg ha^{-1}) the 21% (128,144 km^2) of the 69 NUTS 2 suitable for Camelina cultivation. The remaining 79% (372,230 km^2) performed above the average found in the literature.	validation
4.5. Source data		NO
4.5.1. Source data - Organisation	JRC	NO
4.5.2. Source data - Comment	Data source: https://xxx BIO4A H2020 project results Data provider JRC	NO
5. Frequency and Timeliness of dissemination		NO
5.1. Frequency of dissemination		NO
5.1.1. Frequency of dissemination - Grade	LOW	NO
5.1.2. Frequency of dissemination - Comment	Data are disseminated in 2022	NO
5.2. Timeliness		NO
5.2.1. Timeliness - Grade	LOW	NO
5.2.2. Timeliness - Comment	New data points are disseminated within three years after the reference year	NO
6. Coverage and comparability		NO
6.1. Reference area		NO
6.1.1. Reference Area - Grade	HIGH	NO
6.1.2. Reference Area - Comment	Southern EU Member States defined by Koeppen bioclimatic zones	NO
6.2. Comparability - geographical		NO
6.2.1. Comparability - geographical - Grade	HIGH	NO
6.2.2. Comparability - geographical - Comment	Data are comparable between other Modelling routine that uses the same input data and timespan	NO
6.3. Coverage - Time		NO
6.3.1. Time Coverage - Grade	HIGH	NO

6.3.2. Time Coverage - Comment	Simulated average from 2000-2020.	NO
6.4. Comparability - over time		NO
6.4.1. Comparability - over time - Grade	MEDIUM	NO
6.4.2. Comparability - over time - Comment	Data from 2000-2020 methodology.</p>	NO
7. Accessibility and clarity		NO
7.1. Dissemination format - Publications	Analysis of the data is presented in a scientific paper (Schillaci et al., in press)	NO
7.2. Dissemination format - online database	GIS data (.tiff maps at 500 m) and legends (optional legends .qml) https://xxx	NO
7.3. Dissemination format - other		NO
8. Comment	Copyright/Licence Policy	NO

Table x Metadata table Scenario 211-241-242-243

NUTS_ID	very low	low	moderate	high	very high	km2
ES12	0%	0%	0%	0%	100%	653.125
ES24	57%	40%	3%	0%	0%	37938.13
ES30	1%	79%	19%	0%	0%	4570.625
ES51	0%	59%	23%	9%	9%	13407.5
ES23	51%	49%	0%	0%	0%	1180
CH01	100%	0%	0%	0%	0%	3.75
CH07	0%	0%	100%	0%	0%	2.5
BG42	11%	7%	83%	0%	0%	76.875
BG41	0%	34%	66%	0%	0%	54.375
ES53	0%	2%	11%	38%	49%	4439.375
PT11	0%	10%	27%	16%	47%	12406.88
ITG1	0%	0%	13%	56%	30%	31862.5
ES62	10%	89%	1%	0%	0%	5958.75
ES13	0%	0%	0%	0%	100%	656.25
ITG2	0%	12%	53%	24%	12%	20971.88
ES42	22%	60%	14%	4%	0%	77440.63
ES52	5%	43%	49%	3%	0%	6938.75
ES43	0%	0%	8%	47%	45%	16800
ES21	0%	33%	31%	0%	36%	486.25

ES41	81%	17%	2%	0%	0%	77090.63
ES11	0%	0%	0%	0%	100%	1236.25
ES61	12%	18%	10%	8%	52%	31284.38
ES22	20%	42%	26%	12%	0%	6300.625
ITC1	0%	1%	15%	50%	33%	20711.88
HU23	2%	86%	11%	0%	0%	1874.375
PT18	0%	0%	0%	5%	95%	17164.38
HR03	12%	16%	10%	43%	18%	65.625
HR02	0%	27%	73%	0%	0%	145.625
ITF1	0%	6%	26%	48%	20%	9694.375
ITC2	0%	0%	100%	0%	0%	9.375
ITF2	0%	33%	40%	22%	4%	6242.5
ITC4	1%	2%	19%	43%	35%	23267.5
ITF3	0%	26%	6%	8%	60%	14658.75
PT16	0%	0%	9%	3%	88%	16186.25
PT15	0%	0%	0%	6%	94%	3392.5
PT17	0%	0%	0%	0%	100%	1869.375
ITF4	0%	25%	41%	11%	23%	24445
ITF5	0%	23%	34%	20%	22%	12984.38
ITF6	0%	5%	4%	2%	89%	11463.75
ITC3	0%	8%	0%	1%	91%	1798.75
AL03	0%	43%	0%	0%	57%	4.375
EL62	0%	0%	0%	0%	100%	1668.75
EL63	0%	0%	1%	2%	97%	7086.875
EL41	0%	0%	0%	0%	100%	1818.125
EL42	0%	41%	12%	1%	46%	2166.25
EL51	0%	3%	50%	32%	15%	8368.75
ITI4	0%	2%	3%	15%	81%	20408.13
EL30	0%	0%	38%	62%	0%	1421.25
EL61	0%	15%	62%	15%	8%	8123.125
EL65	0%	5%	22%	19%	54%	7245.625
EL43	0%	13%	28%	24%	35%	2739.375
EL52	0%	28%	72%	0%	0%	15112.5
ITH2	38%	62%	0%	0%	0%	692.5
ITH3	1%	2%	7%	60%	31%	22396.88
EL64	0%	4%	21%	60%	15%	6895
EL54	0%	1%	4%	5%	89%	3682.5
ITH1	92%	8%	0%	0%	0%	99.375
EL53	0%	57%	43%	0%	0%	7251.25
FRL0	7%	10%	26%	42%	16%	9351.25
ITI3	0%	0%	22%	47%	31%	14705.63

FRJ1	0%	3%	25%	33%	40%	8788.75
FRI1	0%	0%	0%	0%	100%	1991.875
FRJ2	0%	1%	50%	46%	3%	22377.5
ITI2	0%	3%	9%	63%	24%	9609.375
ITI1	0%	0%	4%	40%	55%	20680.63
ITH5	0%	1%	69%	30%	0%	36613.75
SI04	9%	40%	30%	11%	9%	2136.25
MK00	0%	59%	41%	0%	0%	31.875
ITH4	2%	0%	1%	31%	67%	6752.5
SI03	1%	55%	44%	0%	0%	2241.25
FRK2	8%	15%	33%	29%	16%	12277.5
FRM0	0%	0%	1%	3%	96%	1594.375
TR21	0%	0%	86%	14%	0%	17.5
HR06	0%	49%	51%	0%	0%	43.125
						784128.1

Table x potential yield in classes and total area per NUTS2.

5. The Environmental sustainability of feedstock potential production on marginal land

The Environmental sustainability of feedstock production was assessed through the measurement of a set of environmental sustainability indicators:

- Soil Erosion
- Soil Pollution
- Soil Nutrient
- Soil Salinization
- Soil Compaction
- Soil Sealing

5.1 Convergence of Evidences approach

Because of the increasing pressures exerted on soil, crop productivity as well as soil biodiversity is under threat. A list of the potential soil indicators take into account the different components of soil physical-chemical properties as well as its capacity to host micro and marcofauna. The EUSO dashboard, including all the LD processes and derived indicators:

- Soil Erosion
- Soil Pollution
- Soil Nutrient
- Soil Salinization
- Soil Compaction
- Soil Sealing),

Defining the potential Soil Degradation, using the Convergence of Evidences approach, the soil indicator taken into account were proposed to experts with different backgrounds in order to assess the potential Environmental sustainability of the feedstock production in the study area. Through an additive aggregation model, this approach allowed us to preliminarily assess the spatial patterns of soil degradation. The land cover analysed is CLC agricultural soils (code 2) which are the most exposed to pressure.

5.1 Results

Each indicator is reclassified in potential risk classes, low, middle and high.

Higher is the number of cases with potential high risk of degradation lower is the environmental sustainability.

Ongoing calculation…

This approach may be used in future research to assess threat at both local and global scale and identify areas of possible risk and, subsequently, design appropriate strategies for monitoring and protection of soil biota.

5 Conclusions

A crucial component contributing to the energy resilience of the European Union is land-use and the cultivation of feedstock for the provision of bioenergy. The spatial distribution of suitable land can affect both quantity and quality of the cropping systems as well as the ecosystems and their services. In addition, energy crop can help in recovering degraded lands if inserted in rotation, to cover the soil throughout the year, and mitigate climate change by storing more carbon and reducing GHG emissions. Land planning will require a special effort in order to improve cropping system resilience and avoid further degradation.

To better manage marginal land, flexible policy and practical solutions are needed to avoid land degradation and the adoption of measures such as nature-based socioeconomic development and policy development toward marginal land management. To preserve the socioeconomic importance of marginal areas, it is critical to develop rural areas that are economically or biophysically marginalised. Bioenergy crops by sustainable integration in cropland rotations is highly recommended.

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