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Carina

D3.1

Report on methodological concept for all assessments

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ABBREVIATIONS

AS	Alternative scenarios
AHP	Analytical Hierarchy Process
BS	Baseline scenarios
BAU	Business as usual
BEP	Break Even Point
BCR	Benefit Cost Ratio
CAPEX	Capital costs
CBA	Cost Benefit Analysis
CF	Cash flow

CFO	Cash flow ratio
EU	European Union
FDR	Financial Discount Rate
FU	Functional unit
GA	Grant Agreement
IRR	Internal Rate of Return
iLUC	Indirect land use
LC	Life Cycle
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
MADM	Multi-attribute decision-aid methods
ROI	Return on Investment
OPEX	Maintenance costs
P&C	Principles & Criteria
NPV	Net Present Value
SB	System boundaries
SDR	Social Discount Rate
S-LCA	Social Life Cycle Assessment
SROI	Social Return of Investment
SMART	Specific Measurable Achievable Reasonable Time-bound
VRE	Value-based resource efficiency
WP	Work Package

1. Executive summary

This document is the first report of the integrated sustainability assessment of the new bio-based CARINA systems. It contains the methodological concepts of the identification of sustainability indicators, the sustainability assessments including the economic, social, environmental assessment and the integrated sustainability assessment of selected CARINA concepts applied in WP3.

2. Introduction to CARINA

As climate change is transforming landscapes, farming sites and arable land is declining and the need for biomass resources for feed, energy and material use is increasing. Suitable crops with high resilience are necessary to adapt to the changing environmental conditions and provide for the bioeconomy.

The CARINA-project is a 4-year long, cross-national, EU funded, innovative action plan within the framework of the Horizon Europe program. The project focuses on the Introduction of two new oilseed crops to new bioeconomy structures – camelina and carinata. Their cultivation is thought to diversify farming systems and produce sustainable low indirect land use (iLUC) feedstocks for the bio-based economy and set an example to demonstrate the effects of a well-designed crop incorporation and combination. To ensure the accuracy and appropriateness of the approaches, 9 Lighthouses, 5 Living Labs and 9 Policy Innovation Labs have been established in Europe to play a major role in the joint development of CARINA innovation actions. The associated countries for the project include Bulgaria, France, Germany, Greece, Italy, Morocco, Poland, Serbia, Slovakia, Spain, Switzerland, Tunisia and the UK.

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NOVAMONT SPA	NVMT
NUSEED EUROPE LTD	NUSEED
RSB ROUNDTABLE ON SUSTAINABLE BIOMATERIALS ASSOCIATION	RSB
TERRES INOVIA	TI

2.1 Objectives

This document has been developed within the framework of the CARINA project and contains the report on methodological concepts for all assessments. Its main objective is to describe the required steps to conduct the sustainability assessment and successfully assess the integration of bio-based CARINA systems.

To ensure the longevity of the implementation of the new concepts and methodologies, several approaches involving stakeholders were conducted. Ecological, environmental, social and integration indicators were assessed within this WP to determine all possible impacts and synergies.

This framework provides an approximation for the qualitative assessment of all possible parameters to determine the required methodology for the integrated sustainability assessment.

3. Methods applied

The Horizon Europe CARINA project focuses on new sustainable and diversified farming systems by adopting two oilseed crops able to provide iLUC feedstocks for the bioeconomy. In this context, WP3 will deliver an integrated sustainability assessment of the CARINA bio-based systems by identification of sustainability indicators, the assessment of economic, social and environmental impacts and conduction of an overall integrated assessment. To help develop a framework to implement CARINA, following steps were taken and summarized below:

Sub-task 3.1.1 (M1-6) had the main goal to top-down derive sustainability indicators. A comprehensive literature review was carried out collecting and selecting relevant strategy documents and possible indicators. Based on the literature review, defined quality criteria and under consideration of the assessments and their limits, a minimum of 10 preliminary literature-based indicators for each category (environmental, social, economic and integrated) could be defined.

In Sub-task 3.1.2 (M8-12) was the second task in which sustainability indicators were tested and further developed to analyse how sustainability effects of CARINA systems can be validated through those indicators. For this, stakeholders were identified and selected, and participated in a co-design workshop together within the WP1 Lighthouses. To test the selected sustainability indicators for their viability and appropriateness, opinions of individual stakeholders were elicited through a series of iterative questions to reach a consensus using the Delphi-method.

Sub-task 3.1.3 (M1-12) was the third task in which the sustainability indicators were finalized by the synthesis of the top-down and bottom-up processes. The results were validated by the respective assessment partner and a descriptive list of 10 selected sustainability indicators per category (economic, social, environmental) as well as integrated/synergetic indicators and a descriptive part were determined.

Lastly, in sub-task 3.1.4 (M8-38) the crop management operations of the different CARINA field experiments identified in T1.1 will be registered in a single common database using Systerre. The indicators identified in T3.2, T3.3 and T3.4 which will be used for the multi-criteria assessment of cropping systems will complete the common database and be calculated either directly from Systerre data or with additional data acquisition. Depending on the entry data required, they will be uploaded in the Systerre calculation program, to make them easily available for all partners in the future.

3.1 Task 3.1 - Identification of sustainability indicators (M1-38)

3.1.1 Sub-task 3.1.1 - Top-down: derivation of sustainability indicators (M1-6)

For the first identification of the indicators, following steps were conducted:

1. Literature review

A comprehensive literature review was carried out with participating institutions to collect relevant literature and strategy documents on the topics of bioeconomy, sustainability and possible indicators (e.g. SDG, Green Deal and EU bioeconomy strategy), as well as existing relevant sustainability standards with defined criteria and indicators (e.g. RSB Principles & Criteria, ISO 13065).

A basic recommendation on relevant literature and parameters was provided. The following selection criteria were identified: language, publication date, relevance, CARINA topics (sustainability, bioeconomy) and indicators included. The literature was further discussed and completed with other WP and project partners based on their expertise.

Based on the described quality criteria, a comprehensive analysis and selection of the documents has been conducted in six selection steps. Thus, a core collection of 154 documents containing title, weblink, author, year, language, scope level, type and comment), was made available for all WP partners.

2. Indicator definition

The literature research provided the fundamental element for the development of the indicators. Based on the classical sustainability framework of the "Three Pillars of Sustainability", four relevant indicator classes with 20 economic, 15 environmental, 16 social as well as 14 synergy/integration indicators were defined. Integrated indicators on one hand can be *synergic integration*, that means one of the identified ones (social, economic or environmental), which have the potential to contribute to more than one pillar of the sustainability. On the other hand, *further integration* indicators were selected, to reflect the integration potential and limitations of bioeconomy concepts. From here on, both synergy and further integration indicators are called as *integration indicators*.

Each Indicator was assigned to a category, a subcategory if applicable, a short description and a measurable unit. The indicators were designed to identify all possible effects of CARINA concepts, measure characteristics of the component groups and provide the basis of the sustainability analysis while also considering the requirements and limitations of the assessments. Furthermore, every indicator was tested according to the SMART-criteria by George T. Doran (1981) to determine if the indicators were specific, measurable, achievable, relevant and timely.

The full literature list and Top-down indicators can be found in the Annex.

3.1.2 Sub-task 3.1.2 - Bottom-Up: test of sustainability indicators (M8-12)

To validate the selection of environmental, economic, social and integrated indicators to be adopted in the sustainability assessments, this subtask presents the methodological steps for the stakeholder engagement and consultation.

1. Stakeholders mapping

The mapping process adopts a snowballing approach, starting from the project partners in WP1 to reach relevant stakeholders. This process benefits from the activities performed in T5.3 (Co-define challenges and co-create social innovation solutions), which elaborated stakeholder factsheets to identify the main actors at each level of the value chain.

2. Stakeholder engagement

After being selected, stakeholders were contacted via e-mail and invited to participate in an online survey. The stakeholders were asked to engage in a co-design process building on the results of the top-down selection of sustainability indicators performed in T3.1.1.

3. Sustainability indicators testing

To test and validate the selected indicators, an online survey was designed to assess the relevance attributed to each indicator.

The scope of the exercise was to select about 10 indicators considered as the most relevant for each sustainability pillar. This bottom-up insight has reinforced the evaluation of the SMART criteria which were pre-emptively assessed during the top-down derivation. The exercise has allowed to select about 40 out of the 65 selected environmental, economic, social and integration indicators (10 for each dimension of sustainability) for the overall sustainability assessment of the CARINA concepts.

At the beginning of the survey, a detailed description of its scope and structure was provided, and information on the country and stakeholder category of each respondent was collected.

The survey was structured in 7 sections, containing approximately 8 questions:

1. General information (up to 4 questions)

2. Brief introduction to the topic

3. Environmental sustainability (up to 2 questions)

4. Social sustainability (up to 2 questions)

5. Economic sustainability (up to 2 questions)

6. Integration (up to 2 questions)

7. Comments (1 question)

The full list of top-down derived indicators for each dimension of sustainability resulting from the qualitative top-down analysis was presented to the respondents, to depict the main aspects to be considered in a comprehensive sustainability assessment of CARINA concepts.

Respondents were asked to express their opinion on the relevance of each indicator on a 1-5 scale ranging from not relevant (1) to very relevant (5). The 10 highest ranked indicators were included in the final set of indicators.

4. Sustainability indicators testing results

21 responses were registered to the survey, distributed as 15 females, 5 males and 1 non-binary. Table displays the frequency of responses per country of provenance, while Table presents the frequency of responses per stakeholder group.

Table 1: Number of respondents per country of provenance.

Country	Number of respondents
France	5
Germany	2
Italy	2
Poland	3
Serbia	3
Spain	4
Switzerland	1
Tunisia	1

Table 2: Number of respondents per group of stakeholders.

Stakeholder group	Number of respondents
Society/research, community, media, private individuals, NGOs, activist groups or universities	14
Upstream/feedstock providers, farmers, associations of farmers or agro-industries	2
Producers, biobased products manufacturers or biorefineries	4
Downstream costumers, buyers, users (chemical industry, food, nutraceutical and feed industry) or biochemicals processing industries.	1

The indicators were prioritised according to the frequency of responses scoring 4 and 5. In case of equally scoring indicators, the frequency of score 5 and the average score were also included as selection criteria.

In the environmental and the social dimensions, 10 indicators were selected according to the frequency of 5 and 4 and included in the final list presented in Table 13: Bottom-Up indicators for the environmental dimension.. In the economic dimension, two indicators scoring equally were then prioritised according to the frequency of responses scoring 5. In the integration dimension, both frequency of score 5 and average value were adopted as selection criteria in case of equally scoring indicators.

The full bottom-up validated indicators can be found in the Annex.

3.1.3 Sub-Task 3.1.3 - Synthesis: finalisation of sustainability indicators (M1-12)

After the Bottom-Up task is completed, a list of the selected and ranked 10 indicators was provided from the bottom-up. In this instance, the indicators were verified in terms of their applicability within the assessment tools. For this, a list of the selected indicators was provided to the assessment partners to confirm that the selected assessment method can evaluate the indicators. Furthermore, calculation methods were discussed and prepared.

In case of the selected economic, environmental and social indicators, the methods have been confirmed by the assessment partners. For the systemic indicators, according to the bottom-up feedback, two indicators were adjusted. The indicators “Combination options” and “Cascading use” were adjusted to “Quality degree reduction” and “Cascading options” to evaluate factors that play into Circularity of the processes accordingly. The precise calculation options of the systemic indicators will be subject of the next project phase. Furthermore, according to the calculation method as well as data availability, the number of indicators can be reduced in the assessments if proved insufficient for example by data unavailability or exceeding correlations.

Thus, the results of the Synthesis included 10 validated and selected economic, social, environmental and integrated indicators from the Bottom-Up process with the name, subcategory if available, description, unit and the clarification of the discussed calculation method. The full list can be found in the Annex.

3.1.4 Sub-Task 3.1.4 - Indicator database (M8-38)

The crop management operations of the different CARINA field experiments identified in T1.1 will be registered in a single common database using the Systerre tool. This tool calculates indicators assessed in T3.2, T3.3 and T3.4 for the multi-criteria assessment of cropping systems which will be included in the common database.

The field results at the time of M12 will be registered by WP1 partners in Systerre. For this, during autumn 2023, ARVALIS will organize bilateral meetings with each WP1 partner responsible of a field experiment to assist them in the cropping system registration process and to check on data quality. The main points of attention are data associated with farmer materials used and economic parameters (e.g., supplies and selling prices). The whole process will be paramount for further analysis of the common database. Thus, given that the bilateral meetings have not yet been performed, the common database with data from the first year is not included here. This also includes the data from the downstream value chain to carry out the overall assessment.

The full common database will be included in D3.5.

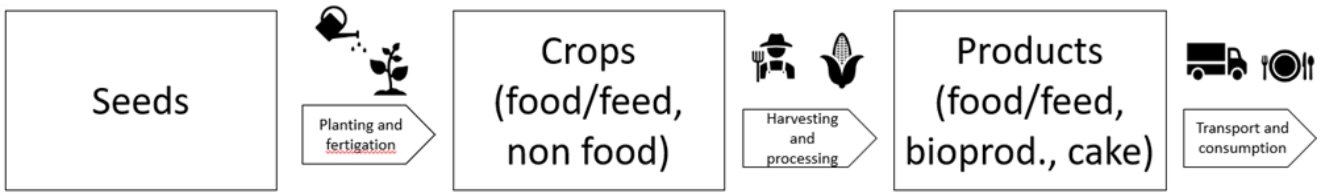
3.2 System boundaries and functional units

For the assessments, system boundaries (SB) were defined for both the baseline scenario (BS) and the alternative scenarios (AS). The SB proposed is a cradle-to-consumer or cradle-to-gate approach contrary to a cradle-to-grave. This approach has been selected due to the end-of-life of the two scenarios which occurs with the consumption of the obtained product itself within the production or with field tests and the consumer (Figure 1).

Figure 1: System boundaries for the baseline scenario.

Baseline scenario (cradle-to-consumer):

Alternative scenario (cradle-to-consumer):



For the functional unit (FU) of the economic assessment, 1 kg of final product was chosen for the following reasons:

1. Since the products have different use destinations, a comparison is only possible on mass or money basis
2. A money-based functional unit might fail to capture the complexity of the systems, as the monetary values and timespans differ greatly. For instance, the growth period is a consistent length until the first harvest compared to the valorisation routes for different products which differ in their transportation routes, volumes and times.
3. A money-based functional unit is dependent on the specific price and the different products' market prices fluctuation.

Thus, a mass-based functional unit (kg^{-1}) was selected for the assessment methods and the value chains. The functional unit for the environmental assessment was slightly adjusted to better reflect the outputs and effects on environmental factors within the value chain to 1 kg CO_2 eq/kg bio-based product.

3.3 Task 3.2 - Economic assessment (M13-36)

Cost Benefit Analysis (CBA) is a methodology used to assess the attractiveness of projects and to determine whether they are in the interest of the public and private sectors. The premise of a CBA is that a project should be implemented only if all the benefits exceed the aggregated costs (Molinos-Senante et al., 2010). CBA performs financial analysis including environmental consequences (externalities) and social perspectives through monetization techniques. CBA applies to cash flow (CF) discount rates across a time horizon to obtain a Net Present Value (NPV) which determines the profitability of the project (Hoogmartens et al., 2014) and it allows to compare the bio-based production system with a business as usual (BAU) situation. Regulation (EU) No 1303/2013 states that a complete CBA must include financial analysis and economic analysis. The first aims i) to assess the project's financial performance indicators, ii) to consolidate project profitability for the project owner and some key stakeholders, iii) to outline the cashflows of socio-economic costs and benefits, and iv) to calculate the present value of future cash flows through a Financial Discount Rate (FDR) (EU, 2014). Economic analysis must be carried out too, to evaluate the project contribution to welfare using shadow prices that evaluate external costs and benefits instead of prices observed in the market. Economic analysis uses a Social Discount Rate (SDR) which reflects the actualization of future costs and benefits from a social point of view (EU, 2014).

Seven steps should be carried out to perform a CBA:

1. Identification of alternative scenarios for the different use cases of low iLUC biobased products developed by the CARINA project.
2. Characterization of the sphere of analysis. This step requires the engagement of the stakeholders involved in the bio-based supply chain including farmers, private companies, policymakers and public authorities, as identified in T5.3.
3. Identification of the reference scenarios. The reference scenarios will be determined based on the selected CARINA value chains of the respective regions.
4. Identification of all the costs and benefits for reference scenario and the alternative CARINA scenarios. This includes the identification of the capital costs (CAPEX) and operation and maintenance costs (OPEX).
5. Setting the time horizon which is the period over which the CBA is realized: for this sector, it has been set at 20 years to be consistent with the literature.
6. Aggregation of costs and benefits and evaluation of Net Present Value (NPV) for all the spheres of analysis. For this purpose, the discounting process is necessary to integrate the preference for the present in the analysis (Declercq et al., 2020). Discounting is the process of assigning a lower weight to a unit of benefit or cost in the future than to that unit in the present time. The formula employed for discounting is:

   $$X_d = X_t\ (1 + d)_t$$

   Where:
   X_t = a cost or a benefit in year t
   X_d = the discounted value of Xt
   d = discount rate

The NPV is equal to the sum of differences of the discounted costs and discounted benefits of the reference scenario and the CARINA alternative scenarios. If the NPV > 0, the scenario is considered profitable. The choice of appropriate discount rate is a debated point since studies in literature use different values according to the weight assigned to future costs and benefits.

7. Sensitivity Analysis of the NPV. The sensitivity analysis evaluates the robustness of the CBA parameters and how their variation affects the NPV (Garcia et Pargament, 2015). This can be applied to CBA varying some range of inputs or performing a Monte Carlo analysis which is a multiple regression analysis with standardized regression coefficients (*ibidem*). It aims to test the values of some key but uncertain parameters - defined by their minimum and maximum values – and to analyse the dispersion of the results.

Table 3Table 3 presents the preliminary indicators derived from the top-down selection process, that are selected through the bottom-up testing phase (see Task 3.1.2 Bottom-Up). For the economic dimension, the description of the indicators is further explained with an equation. Being that CBA addresses the business level and not the whole life cycle of the analysed bio-based products, indicators are assessed at each stage of the value chain, and then the resulting metrics are aggregated in a comprehensive evaluation to assess the benefit/cost ratio on a defined functional unit.

Table 3: Set of possible indicators for the economic dimension.

Indicator	**Short description**	**Unit**
Investment in tangible goods ratio	ITG = Capital Investments / Total Expenses	%
Gross Margin (GM)	GM=Total Gross Revenue - Total Cost / Total Gross Revenue	%
Net margin	NM= Total Net Revenue - Total Cost / Total Net Revenue	%
Gross turnover	GT = Total sales	€
Gross value added (GVA) per person	GVAp = Total Net Revenue - Total Cost / n of employees	€
Gross value added	GVA = Total Net Revenue - Total Cost	€
Net Present Value (NPV);	NPV = Cashflow / (1+i)^t I= discount rate T = time of the investment	€
Return on Capital Employed (ROCE %)	ROCE = EBIT / Total assets - Total Liabilities	%
OPEX	OPEX = Total Operative Costs	€
CAPEX	OPEX = Total Capital Investments	€
Gross product	GP = Total sales	€
Economic efficiency of inputs	EII = GP - inputs / inputs	%
Return on Investment (ROI)	ROI = Total Benefits - Total Costs / Total Cost	%
Internal Rate of Return (IRR)	NPV = 0 = Cashflow / (1+IRR)^t	%

Break Even Point (BEP)	BEP is where Total Revenues / Fixed Costs = 1	%
Benefit Cost Ratio (BCR)	BCR = Total Benefits / Total Costs	%
Value-based resource efficiency (VRE)	VRE = Total outputs / Total Inputs x Weighting factor	%
Cash Flow Ratio	CFR = Total Cashflow / Total Liabilities	%
Fixed assets to Total Assets	Fixed assets to Total Assets	%

3.4 Task 3.3 - Social assessment (M13-36)

Social Life Cycle Assessment (S-LCA) is an assessment technique that aims to assess the negative (footprint) and positive (handprint) social and socio-economic impacts of products, services, and processes along their life cycle, encompassing extraction and processing of raw materials the manufacturing, distribution, use, re-use maintenance, recycling and final disposal (UNEP 2020). Differently from a Life Cycle Assessment, it is not a standardized methodology, despite that, UNEP (2020) published guidelines to develop a methodological framework. S-LCA differs from other methodologies since it addresses the stakeholders directly and indirectly involved in the life cycle of the product, service, and process according to the study's purpose. Therefore, impacts are organized according to different stakeholder categories and impact subcategories (akin to midpoint or endpoint categories in LCA).
The stakeholder categories are selected from the ones indicated by UNEP (2020), according to the relevance of actors influencing or being influenced by the analysed product, process, or service. Then, each selected stakeholder category is associated to one or more impact subcategory representing the midpoint or endpoint categories affecting that specific stakeholder.

As for other life cycle thinking-based methodologies, S-LCA is carried out in four main steps: goal and scope definition, life cycle inventory, impact assessment and result interpretation.
To define the goal and scope of the assessment, a preliminary stakeholder mapping was performed to identify the main relevant actors to be involved in the process and define the stakeholder categories related to impacts. Stakeholder factsheets were developed in T5.3 to identify relevant stakeholders for each of the value chain stages considered.
Stakeholder engagement is recommended in S-LCA to ensure appropriate context-based social impact assessment. After being selected, relevant stakeholders are engaged in a participatory process. Stakeholders are asked to evaluate a set of previously selected indicators (see Task 3.1.2 Bottom-Up) according to their effectiveness in evaluating sustainability of the CARINA concepts. Table 4 presents the indicators selected for the bottom-up testing.

Table 4: Set of possible indicators for the economic dimension.

Indicator	Short description	Unit
Average wages per person	Average wage PER HOUR per person for each category (supply chain stage) / national average wage per person for each category	€
Estimated permanent work	Number of fixed-term contracts in % of the total number of contracts	%
Work-related risks	Hours of risk exposure	n/year
Occupational health and safety	Number of occupational accidents per year	n/year
Working hours per week	Working hours per week per person (relative to working hours per week as indicated in the contract)	n or %
Disadvantaged workers	Number of workers from vulnerable groups as % of the total number of workers	%
Equal pay (Gender)	Gender wage gap - potentially to be compared to the national average	%
Equal opportunities	Rate of female employees (and rate of female employees in managerial position)	%
Measures to improve gender equality	Existing/implemented measures to improve gender equality	Yes/No

Employment	Average number of employees	n
Local employment	Number of local (from the region) employees hired, in % of the total number of employees hired	%
Income stabilisation	Average income gap (of the last 3 years) between scenario a and b, where a is without cover crop and b is with cover crop	%/year
Tax exemptions	% on total revenue of tax exemptions for aid-funded projects	%
Equal distribution of the generated value	Equity in distribution of generated value (or profit) among the FSC actors (i.e. how much of the profit is generated within each of the FSC stages) calculated as Gini index	%/year
Number of employees trained	Number of employees trained as % of the total number of employees	%/year
Training and re-qualification of the workforce	Number of people belonging to the workforce trained and/or re-qualified	%/year

After having verified data availability and quality through participatory approach, a data collection strategy is developed including guidelines to facilitate the data gathering process and ensure consistency throughout the assessment steps. Data collection protocols are developed in synergy with the Systerre software.

In the Impact Assessment phase, that aims at "*calculating, understanding and evaluating the magnitude and significance of the potential social impacts of a product system throughout the life cycle of the product*" (Norris, Traverso, and Ekener 2020) inventory data are linked and aggregated within impact subcategories (classification), and results for the subcategory indicators are calculated (characterization) (Valdivia et al. 2013). Given the nature of social phenomena, the impacts assessed through a S-LCA are necessarily linked to a certain degree of uncertainty, as it is difficult to identify deterministic cause-effect relationships when dealing with social issues.

The UNEP (2020) guidelines proposed two different approaches to perform a Social Life Cycle Impact Assessment, namely reference scale (Type I) and impact pathways (Type II).

The reference scale approach is aimed at measuring the positive or negative performance of the product, service, or process, by comparing its impacts to a baseline value (for instance a national or international law or standard). This method is able to conduct social performance studies in sectors that are featured by a conspicuous availability of reference data for building baseline values, and primary data to compare with, as it is the case with large scale industrial companies.

Conversely, the impact pathways approach is borrowing the conceptual framework of conventional LCA. Characterization factors are applied to inventory indicators to show their impacts on areas of protection through impact pathways, passing from midpoint and endpoint categories. As it is the case with chemical-environmental mechanisms in conventional LCA, the allocation of impacts in S-LCA is following social mechanisms. This method is particularly suited to model the assessment on a clearly defined value chain and can exploit the results from both LCA and LCC to propose a promising framework addressing social impacts.

These two methods might be combined to propose a mixed method approach employing both qualitative and quantitative data: it has been demonstrated that such a methodology is best suited to address the complexity of social impacts (Timans, Wouters, and Heilbron 2019).

Finally, a scoring system can be developed to facilitate the dissemination of the assessment outcomes thanks to a score representing the social sustainability performance of the assessed case study.

To summarize, the main methodological steps are described below:

1. Carry out a first stakeholder mapping
2. Co-define the goal and scope of the analysis, and set the functional unit and system boundaries
3. Define a stakeholder involvement strategy
4. Co-define indicators and assessment strategy with stakeholder: define if the indicators are to be assessed qualitatively (e.g. reference scale method) or quantitatively (e.g. impact pathways method), and potential weighting strategy
5. Associate indicators to stakeholder categories and subcategories
6. Develop data collection protocols and with with Systerre
7. Collect data
8. Run the analysis
9. Interpret results and potential scoring strategy

3.5 Task 3.4 - Environmental assessment (M13-36)

The environmental impacts associated with the value chain that is analysed and defined in this deliverable, will be assessed in comparison to the reference scenarios. Environmental impacts will be identified, as well as the indicators that are going to be used for the evaluation.

Table 5 presents the environmental indicators derived from the top-down selection process, that were selected through the bottom-up testing phase (see 3.1.2 Bottom-Up).

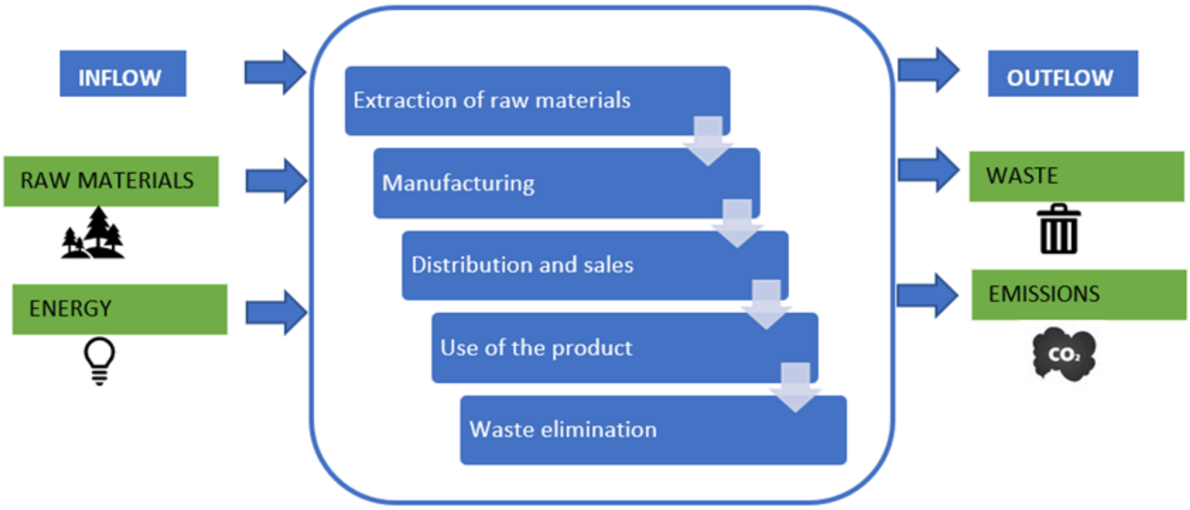
Table 5: Set of possible indicators for the environmental dimension.

Indicator	Short description	Unit
Climate change	GHG emissions	g CO_2
Water management	Implementation of water management plan. The water management plan (both for rain-fed and irrigated crops) shall contain good water management practices to optimise water use.	Yes/No
Water availability	Operations are located in a region with medium, high or extremely high water stress	High/medium/low risk (Operations are not located in a region with water stress)
Water saving	Implementation of water saving practices	Yes/No
Water depletion	Operations affect the depletion of surface or groundwater resources below replenishment capacities	Yes/No
Water quality	Wastewater or runoff that contains potential organic and mineral contaminants is treated or recycled to prevent any negative impact on humans, wildlife, and	Yes/No

	natural compartments (water, soil).	
Natural protected areas	Operations avoid negative impacts on biodiversity, ecosystems, and conservation values. Is the operation located in any nationally/regionally or internationally legally protected area?	Yes/No
Biodiversity conservation	Ecological corridors are protected, restored or created to minimize habitat fragmentation	Yes/No
Deforestation risk	Risk of forest decrease in the area where crop is located.	High/medium/low risk
Soil conservation	Increase of soil organic matter content due to soil management practises	Organic matter content measure (>1%)
Soil quality	Measures to improve soil health are put into place: direct seeding, maintenance of soil cover, crop rotation	Yes/No
Land use type	Operations contribute to land use change	Yes/No
Circular resource use	Use of recycled materials on total materials used	%
Resource use efficiency	Use of renewable energy during the process	Yes/No
Heat efficiency	Use of renewable energy during heating	Yes/No

For the climate change indicator (Table 5), GHG emissions will be calculated via a GHG Life Cycle Assessment (LCA). LCA is a methodologic tool which aims to calculate the environmental impact of a product, process or system throughout its entire life cycle from the raw material to its end of life (Figure 2). The methodology is based on the review and analysis of the inputs and outputs of the system to obtain, as a result, its potential environmental impact. The objective is to establish strategies to reduce these impacts.

Figure 2: Life cycle perspective and stages.



The LCA methodology used will be based on the RSB Standard for Advanced Products. The Standard for Advanced Products is one of several standards, procedures and guidance documents that are to be used by producers to show their compliance with the RSB Principles & Criteria (P&C) (Figure 2) to carry the RSB's best-in-class Certification. This Standard is for use by producers of non-energy products.

The RSB has a GHG tool that will be used to estimate the total GHG emissions for the supply chain. The following elements are required by the RSB GHG methodology and will be included in the GHG emission calculation:

- Emissions from the extraction or cultivation of raw materials shall include emissions from the extraction or the cultivation process itself, from the collection of the raw materials, from waste and leakage including field emissions and from the production of chemicals or products used in the extraction or cultivation.
- Annualised emissions from carbon stock changes caused by land-use change shall be calculated by dividing the total emissions equally over 20 years. GHG emissions from any land use change that has occurred since January 2008 shall be considered.
- Emissions from processing shall include emissions from the processing itself, from waste and leakage, from the production of chemicals or products used in processing.
- Emissions from transport and distribution shall include emissions from transport of raw materials, intermediates and final products from storage of materials as well as distribution: All relevant transport and distribution steps shall be considered.

To compile all information related to GHG emissions from crop production, transport and processing, a data collection worksheet will be created and shared with partners. For the crop related information, data will be gathered using Syterre tool.

Steps to be followed for the GHG calculations will include:

1. Define boundaries and functional use of the value chain
2. Define CARINA reference case studies to be assessed
3. Define a process flow diagram for each CARINA case study
4. Define a reference scenario to compare with CARINA concept
5. Prepare worksheet with the information needed for the environmental assessment
6. Share the data collection worksheet with partners involved
7. Collect data and analyse it (inventory data collection). It might require literature data searching
8. Preliminary values shared with partners
9. Sensitivity assessment
10. Final value and reporting

The remaining environmental indicators (Table 3) can be evaluated based on legislation or data extracted from regulations that should be fulfilled. The RSB provides a robust standard, the 12 RSB P&C) (Figure 3), which provides a framework for ensuring that any biomaterial operation mitigates risks and creates positive impacts for stakeholders.

Figure 3: RSB Principles & Criteria. The full RSB P&C may be found here: https://rsb.org/wp-content/uploads/2020/06/RSB-STD-01-001_Principles_and_Criteria-DIGITAL.pdf

The RSB P&C are divided into Legal, Management, Environmental, and Social criteria. The Environmental criteria will be used in this assessment. It can be applied at broad geographical scales and can be used to constrain potential oil crop feedstock production to remain within certain environmental sustainability boundaries.

3.6 Task 3.5 - Integrated sustainability assessment (M34-46)

3.6.1 Sub-task 3.5.1 - Quantification of synergic indicators (M34-46)

The quantification and calculation methods of the synergetic and integrated indicators are determined with WP2 and WP1 partners. For this, a questionnaire with the integrated indicators determined in Task 3.1.1 to 3.1.3 will be prepared and provided to partners. After exchange, the calculation, quantification methods or estimations for each CARINA concept will be finalized and added to the indicator sheet.

3.6.2 Sub-task 3.5.2 - Overall sustainability assessment (M34-46)

■ Objective

The objective of the integrated assessment in T3.5, as stated in the DoA of CARINA project, is to assess the global sustainability of farms including either camelina or brassica carinata and to compare it to their local reference that do not grow these crops. However, the scope of CARINA goes beyond the farm level by including tasks dealing with downstream actors of the agricultural value chain. Consequently, T3.5 will try to improve an existing methodology of integrated assessment to include indicators related to the activities of these downstream actors, i.e., to produce oil, cake or biopesticides from these two crops. Thus, the assessment of sustainability in T3.5 will be more complete and in line with the rationale of the CARINA project.

In short, the integrated assessment will compare 2 different value-chains in a country:

1. Baseline value chain producing food / feed crops
2. CARINA value chain: food / feed crop + non-food crop + oil / cake / bioproducts from either camelina or brassica carinata.

■ Methods

A large body of scientific literature has shown that innovative cropping systems using diversification practices can lead to improved sustainability over their low diversity references. However, several studies have suggested that interactions between diversification practices may not always be positive and could lead to trade-offs or antagonisms, i.e., ecosystem disservices (Martin et al., 2020; Palomo-Campesino et al., 2018). Consequently, it is important to assess the performance of innovative cropping systems on all dimensions of sustainability, i.e., economic, social and environmental.

Several methods to assess the sustainability of cropping systems are available. Among them are multi-attribute decision-aid methods (MADM) which have been successfully implemented in the assessment of agricultural sustainability (Angevin et al., 2017; Sadok et al., 2008). The DEXiPM model from the DEXi® (Bohanec, 2015) software is a qualitative MADM method that has been used to assess and compare the performances of arable cropping systems by considering all three dimensions of sustainability (Pelzer et al., 2012). Following the DoA of the CARINA project, the DEXiPM will be adapted to perform the integrated assessment.

For the system boundaries of the integrated assessment, the same system boundaries determined for the economic, environmental and social assessments will be used. For this, the diversification practise and cropping system used to grow camelia or brassica carinata (intercropping/double cropping, as shown in Table 6) and context (regular vs. marginal) are relevant to determine.

Table 6: Integrated assessment system boundaries according to the context.

Context	Marginal lands	Double crop system	Intercropping	Relay cropping
System boundaries	Two years From the first main crop to camelina/carinata crop	Two years Of double cropping with 1st primary crop – camelina/carinata and 2nd primary food crop	Two years From the association to the following primary crop	Two years From the first main crop to camelina/carinata planted at the end of the cycle of a second main crop
Example	Reference system: Wheat / Wheat CARINA system: Wheat / Camelina	Reference system: Wheat / Sunflower CARINA system: Wheat / Camelina + Sunflower	Reference system: Wheat / Sunflower CARINA system: Wheat / Camelina combined with Pea	Reference system: Wheat / Barley CARINA system: Winter Barley + B. Carinata (sown in barley) / Wheat

For the downstream observation, the value chains from the farm to the final product will be determined. These include:

- Oil for jetfuel (GHG, …)
- Feed (distance, quality, composition, protein autonomy)
- Biopesticides (job creation, contamination, …)

Data availability will be key for the definition of system boundaries of the downstream parts of the value-chain.

Selection of indicators and calculation

The evaluation process of the value-chain performances will start with the selection of indicators. Indicators at the farm level will be provided by Systerre and those at downstream levels by selecting indicators from T3.2, T3.3 and T3.4. It is likely that all indicators from these tasks will not fit the DEXiPM model even if we adapt the model, mainly because of redundancy with indicators at the farm level. The selection of final indicators will be done with WP3 partners during the project and justifications included in the D3.5.

Quantitative indicators values will be transformed into qualitative variables, compatible with the DEXiPM model, by discretisation, using specific thresholds defined by WP3 partners and relevant partners from other WPs (e.g., WP1 and WP2) to fill in the basic criteria of the model. Note that some input data were directly based on qualitative data obtained from expert knowledge of the lighthouses. Thresholds used will be the same for the innovative and reference systems of a given experiment but may differ according to the country to consider economic, social and environmental discrepancies. The global sustainability of a cropping system is then evaluated by aggregating the score of its economic, social and environmental dimensions with each dimension accounting for a third of the final global sustainability score. Integrated indicators of the integrated dimension are currently not included in the DEXiPM model; however, the model can be extended to include the indicators according to downstream value chain data. This data will be provided by WP2.

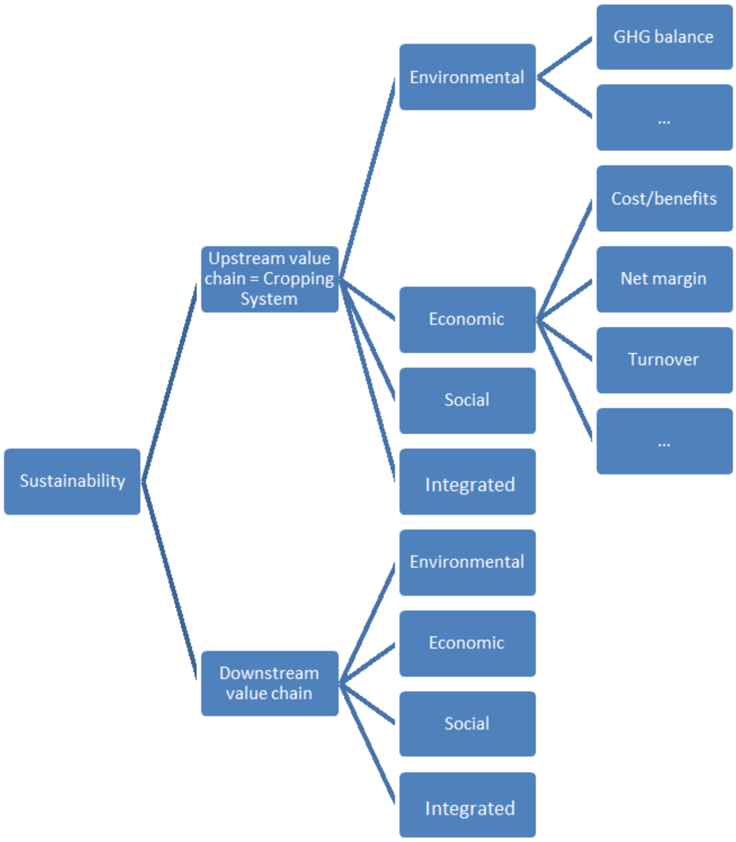


Figure 4: Conceptual representation of the DEXiPM model. Includes adaptations to consider the sustainability of downstream value chain.

Figure 4 is a conceptual representation of the DEXiPM model with adaptations to consider the sustainability of downstream value chain. The usual DEXiPM model contains only sustainability criteria concerning the cropping system or farm level. (i.e., upstream value chain, Figure 4). Criteria concerning downstream value chain will be added to the model to meet our integrated assessment objectives. The indicators proposed in other tasks of WP3 will contribute to build this addition to the usual DEXiPM model.

Pending topics to be discussed with relevant CARINA partners include the discussion of the indicators used to build the additional model and associated thresholds and the definition of the data which will be used for the integrated assessment in the downstream value chain.

3.6.3 Sub-task 3.5.3 - Contribution to the overall strategies (M34-46)

In this subtask, the contribution of the CARINA concepts to selected strategies identified in Task 3.1 will be assessed to contribute to the European Commission's Knowledge Centre for Bioeconomy (JRC). The indicators relevant to the strategies will be indicated and interpreted, with the contribution of all partners. The results will be presented to the primary producers in question in collaboration with WP5 as text and visuals for easy interpretation of contributions to strategy documents.

4. Annex

4.1. List of Bioeconomy Documents

Table 7: List of selected Bioeconomy Documents for the Consortia

Nr.	Title	Author	Publishing year	Web Link	Contact CARINA Partner	Language	Level	Type	Comment
1	Sustainable Development Goals	United Nations	2015	https://sdgs.un.org/	DBFZ	English	Global	Strategy	Several indicators (economic, social, environmental). Some works have been done to link SDGs with bioeconomy, see further literature below
2	European Green Deal	European Commission	2020	https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en	DBFZ	English	European	Strategy	Some studies dealing with bioeconomy and GreenDeal, see below
3	A sustainable bioeconomy for Europe	European Commission	2018	https://op.europa.eu/en/publication-detail/-/publication/edace3e3-e189-11e8-b690-01aa75ed71a1/language-en/format-PDF/source-149755478#	DBFZ	English	European	Strategy	Three main objectives, 14 measures. There are indicators reaching the goals set by the strategy
4	RSB Principles and criteria	RSB	2022	https://rsb.org/wp-content/uploads/2020/06/RSB-STD-01-	RSB	English	Global	Standard	Development of principles and criteria for the production of

				001_Principles_and_Criteria-DIGITAL.pdf					biomass, biofuels and bio-materials
5	ISO 13065	International Standards Organisation	2021	https://www.iso.org/standard/52528.html	RSB	English	Global	Standard	Sustainability standards for bioenergy supply chain
6	Linking the bioeconomy to the 2030 sustainable development agenda: Can SDG indicators be used to monitor progress towards a sustainable bioeconomy?	Calicioglu Özgul & Anne Bogdanski	2021	https://www.sciencedirect.com/science/article/pii/S1871678420301886	DBFZ	English	Global	Research	See Table 2. Several SDG Indicators named for bioeconomy
7	Bioeconomy & European Green Deal. The bioeconomy contributes to the goals of the Green Deal.	Knowledge Centre for Bioeconomy	2019	https://knowledge4policy.ec.europa.eu/bioeconomy/bioeconomy-european-green-deal_en	DBFZ	English	European	Strategy	
8	UFZ Discussion Paper - Towards a Holistic and Integrated Life Cycle Sustainability Assessment of the Bioeconomy – Background on Concepts, Visions and Measurements	Zeug, Walther; Bezama, Alberto; Thrän, Daniela	2020	https://www.ufz.de/index.php?de=20939&pub_data[function]=showFile&pub_data[PUB_ID]=23558	DBFZ	English	Global	Research	Social, environmental and economic LCAs
9	A framework for implementing holistic and integrated life cycle sustainability assessment of regional bioeconomy	Zeug, Walther; Bezama, Alberto; Thrän, Daniela	2021	https://link.springer.com/article/10.1007/s11367-021-01983-1	DBFZ	English	Global	Research	Possibilities of indicator sets
10	Indicators to monitor and evaluate the sustainability of the bioeconomy	Bracco, Stefania et al.	2019	https://www.fao.org/3/ca6048en/CA6048EN.pdf	DBFZ	English	Global	Strategy	Several indicators to monitor the sustainability of bioeconomy

11	Systemisches Monitoring und Modellierung der Bioökonomie	Mittelstädt, Nora & Zeug, Walther	2019	https://symobio.de/wp-content/uploads/2019/11/2019-10-22-WP-1.2-Rechtsrahmen-der-Biooekonomie-Abschlussbericht-Mittelstaedt.pdf	DBFZ	German	Other	Research	Bioeconomy governance assessment. EU and German level.
12	Bioeconomy: tapping natural and human resources to achieve sustainability	Diaz-Chavez, Rocio; Mortensen, Sofie & Wikman, Anna	2019	https://www.sei.org/publications/bioeconomy-natural-human-resources-sustainability/	DBFZ	English	Global	Research	Indicator Review linked to the SDGs
13	Conceptualization of an Indicator System for Assessing the Sustainability of the Bioeconomy	Egenolf, Vincent & Bringezu, Stefan	2019	https://www.mdpi.com/2071-1050/11/2/443	DBFZ	English	Other	Standard	Conceptualization of Footprint indicators for the German National Bioeconomy Monitoring Report
14	Evaluation of bioeconomy in the context of strong sustainability	Liobikiene, Genovaite; Balezentis, Tomas; Streimikiene, Dalia; Chen, Xueli	2019	https://onlinelibrary.wiley.com/doi/10.1002/sd.1984	DBFZ	English	Global	Research	Reviewing Bioeconomy in context of weak and strong sustainability
15	Socioeconomic Indicators to Monitor the EU's Bioeconomy in Transition	Ronzon, Tévécia & M'Barek, Robert	2018	https://www.mdpi.com/2071-1050/10/6/1745	DBFZ	English	European	Research	Quantified Socioeconomic Indicators of the EU Bioeconomy in 2015
16	Novel regional and landscape-based approaches to govern sustainability of bioenergy and biomaterials supply chains	Diaz-Chavez, Rocio & van Dam, Jinke	2020	https://www.ieabioenergy.com/wp-content/uploads/2020/07/Novel-regional-and-landscape-based-approaches-to-govern-	DBFZ	English	European	Research	Landscape based approaches for biobased approaches with also discussed drivers of

				sustainability-of-bioenergy-and-biomaterials-supply-chains.pdf					governance approaches
17	Roadmap for the blue bioeconomy	Gregersen, Olavur; Joller-Vahter, Liina; van Leeuwen, John; Moncheva, Snejana; Petersen, Jens Kjerulf; Schoonderbeek, Wilco; Vieira, Vitor Verdelho; Vieira, Helena; Walraven, Maye	2019	https://op.europa.eu/o/opportal-service/download-handler?identifier=7e963ebb-46fc-11ea-b81b-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part=	DBFZ	English	European	Strategy	Blue Economy Strategy; bioeconomy in relation to sea and ocean resources
18	EU Bioeconomy Strategy Progress Report	European Commission	2022	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0283&from=EN	DBFZ	English	European	Policy	Status Report of Progress of Implementation of EU Bioeconomy Strategy
19	National Bioeconomy Strategy	BMBF; BMEL	2020	https://www.bundesregierung.de/breg-de/service/publikationen/national-bioeconomy-strategy-1998714	DBFZ	English	Other	Strategy	National Bioeconomy Strategy

20	Environmental impact assessments of innovative bio-based product	European Commission	2019	https://op.europa.eu/o/opportal-service/download-handler?identifier=15bb40e3-3979-11e9-8d04-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part=	DBFZ	English	European	Other	Provide science-based facts and evidences on the environmental impacts of innovative bio-based products and mostly plastic products compared to petrochemical counterparts, in order to support the future bioeconomy policy and decision-making at EU level. Seven cradle-to-grave LCA case studies were carried out covering three major commercialised bio-based polymers
21	Effective bioeconomy? a MRIO-based socioeconomic and environmental impact assessment of generic sectoral innovations	Asada, Raphael; Cardellini, Giuseppe; Mair-Bauernfeind, Claudia; Wenger, Julia; Haas, Verena; Holzer, Daniel; Stern, Tobias	2020	https://www.sciencedirect.com/science/article/abs/pii/S0040162519316075	DBFZ	English	European	Research	Multi Criteria Input Output Assessment of a European Bioeconomy

22	Quantifying the global cropland footprint of the European Union’s non-food bioeconomy	Bruckner, Martin; Häyhä, Tiina; Giljum, Stefan; Maus, Victor; Fischer, Günther; Tramberend, Sylvia; Börner, Jan	2019	https://iopscience.iop.org/article/10.1088/1748-9326/ab07f5	DBFZ	English	European	Research	Quantification of Worldwide cropland use of non-food bioeconomoy
23	Global Sustainable Development Report	D. Sachs, Jeffrey; Lafortune, Guillaume; Kroll, Christian ; Fuller, Grayson; Woelm, Finn	2022	https://s3.amazonaws.com/sustainabledevelopment.report/2022/2022-sustainable-development-report.pdf	DBFZ	English	Global	Policy	Report on the global progress on sustainab iliuty
24	Power 4Bio Project	European Commission	2022	https://power4bio.eu/	DBFZ	English	European	Research	EU project on emPOWERing regional stakeholders for realising the full potential of european BIOeconomy. Could be very relevant for CARINA!!
25	Common Agricultural Policy (CAP)	European Commission	2021	https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/new-cap-2023-27_en	DBFZ	English	European	Policy	CAP reform, December 2021

26	A new EU Forest Strategy: For forests and the forest-based sector	European Commission	2021	https://environment.ec.europa.eu/strategy/forest-strategy_en	DBFZ	English	European	Policy	
27	Blueprint for the EU Forest-based Industries (SWD(2013)343)	European Commission	2013	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013SC0343&from=DA	DBFZ	English	European	Policy	
28	Blue Growth: Opportunities for marine and maritime growth“ Report on the Blue Growth Strategy, Towards more sustainable growth and jobs in the	European Commission	2012	https://wedocs.unep.org/handle/20.500.11822/11159	DBFZ	English	European	Policy	
29	Strategic guidelines for the sustainable development of EU aquaculture	European Commission	2021	https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/strategic-guidelines-sustainable-development-eu-aquaculture	DBFZ	English	European	Strategy	
30	Renewable Energy Directive II	European Commission	2018	https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0028&from=EN	DBFZ	English	European	Policy	Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources
31	Energy Roadmap 2050	European Commission	2011	https://energy.ec.europa.eu/system/files/2014-10/roadmap2050_ia_20120430_en_0.pdf	DBFZ	English	European	Strategy	Strategy for RE in Europe by 2023: impact assessments

									and scenario analysis
32	The role of waste-to-energy in the circular economy	Asian Development Bank	2020	https://www.adb.org/sites/default/files/institutional-document/659981/waste-energy-circular-economy-handbook.pdf	DBFZ	English	Global	Policy	Handbook on waste-to-energy activities and best practices in the deployment of waste-to-energy technologies. The report features both technically proven and emerging technologies implemented by both public and private sectors.
33	Preparing for our future: developing a common strategy for key enabling technologies in the EU	European Commission	2009	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0512&from=EN	DBFZ	English	European	Policy	
34	Towards a circular economy: a zero-waste programme for Europe	Deselnicu, Dana Corina; Deselnicu, Viorica; Militaru, Gheorghe	2018	https://www.researchgate.net/profile/Viorica-Deselnicu/publication/328682998_Towards_a_Circular_Economy-_a_Zero_Waste_Programme_for_Europe/links/5c5a9b2492851c48a9bd7e1f/Towards-a-Circular-Economy-a-Zero-Waste-Programme-for-Europe.pdf?origin=publication_detail	DBFZ	English	European	Research	
35	Closing the loop — An EU action plan for the circular economy	European Commission	2015	https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-	DBFZ	English	European	Strategy	

				99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF					
36	Research trends: Bioeconomy politics and governance	Böcher, Michael, et al	2020	https://www.sciencedirect.com/science/article/abs/pii/S1389934120301581	DBFZ	English	Global	Research	
37	Governance of the Bioeconomy: A Global Comparative Study of National Bioeconomy Strategies	Dietz, Thomas, et al.	2018	https://www.econstor.eu/bitstream/10419/191783/1/zef-dp-264.pdf	DBFZ	English	Global	Research	Bioeconomy & Governance
38	Die Governance der Bioökonomie – Herausforderungen einer Nachhaltigkeitstransformation am Beispiel der holzbasierten Bioökonomie in Deutschland	Gawel, Erik, et al	2016	https://www.ssoar.info/ssoar/bitstream/handle/document/47319/ssoar-2016-gawel_et_al-Die_Governance_der_Biookonomie_-.pdf?sequence=1&isAllowed=y&lnkname=ssoar-2016-gawel_et_al-Die_Governance_der_Biookonomie_-.pdf	DBFZ	German	Other	Research	Bioeconomy & Governance
39	Sustainability governance of bioenergy and the bioeconomy	Stupak, Inge, C. Tattersall Smith, and Nicholas Clarke.	2021	https://task45.ieabioenergy.com/wp-content/uploads/sites/13/2021/10/IINAS-2021-Sustainability-governance-of-bioenergy-and-bioeconomy-final.pdf	DBFZ	English	Global	Research	Bioeconomy & Governance
40	Joint survey on bioeconomy policy developments in different countries.	RC, BBI JU and IEA Bioenergy	2018	https://task42.ieabioenergy.com/publications/joint-survey-on-bioeconomy-policy-developments-in-different-countries/	DBFZ	English	European	Research	Information on bioeconomy strategies or policies in the EU Member States and other countries

41	The framework conditions must be aligned to the requirements of the bioeconomy	Kircher, Manfred	2021	https://www.sciencedirect.com/science/article/pii/S2667041021000033?via%3Dihub	DBFZ	English	Global	Research	Bioeconomy and zero-emission energies to be implemented synergistically. Actual policy framework needs to be further developed for the transition to the bioeconomy.
42	Food, energy or biomaterials? Policy coherence across agro-food and bioeconomy policy domains in the EU	Muscat, A., et al.	2021	https://www.sciencedirect.com/science/article/pii/S1462901121001210	DBFZ	English	European	Research	Bioeconomy & policy
43	Policy review for biomass value chains in the European bioeconomy	Singh, Asha; Thomas Christensen; & Calliope Panoutsou	2021	https://www.sciencedirect.com/science/article/pii/S2589791820300256	DBFZ	English	European	Research	Bioeconomy & policy
44	Rising policy conflicts in Europe over bioenergy and forestry	Söderberg, Charlotta; & Katarina, Eckerberg	2013	https://www.sciencedirect.com/science/article/pii/S1389934112002420	DBFZ	English	European	Research	Bioeconomy & policy
45	Strategies and Policies for the Bioeconomy and Bio-Based Economy: An Analysis of Official National Approaches	Staffas, Louise; Mathias, Gustavsson & Kes, McCormick.	2013	https://mdpi-res.com/d_attachment/sustainability/sustainability-05-02751/article_deploy/sustainability-05-02751-v3.pdf?version=1424777358	DBFZ	English	Global	Research	Bioeconomy & policy
46	Is bioeconomy policy a policy field? A conceptual framework and findings on	Töller, Annette	2021	https://www.tandfonline.com/doi/full/10.1080/1523908X.2021.1893163	DBFZ	English	European	Research	Bioeconomy & policy

	the European Union and Germany	Elisabeth, et al.							
47	Perspectives on the bioeconomy as an emerging policy field	Vogelpohl, Thomas, and Annette Elisabeth Töller	2021	https://www.tandfonline.com/doi/pdf/10.1080/1523908X.2021.1901394	DBFZ	English	Global	Research	Bioeconomy & policy
48	Aspirational principles and criteria for a sustainable bioeconomy	FAO	2021	https://www.fao.org/3/cb3706en/cb3706en.pdf	DBFZ	English	Global	Policy	Assessment criteria and guiding principles for bioeconomy
49	Nachhaltige Entwicklung in Deutschland Indikatorenbericht 2021	DeStatis	2021	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Nachhaltigkeitsindikatoren/Publikationen/Downloads-Nachhaltigkeit/indikatoren-0230001219004.pdf;jsessionid=9FCABF9293EE939754A77D98A4FCE156.live731?__blob=publicationFile	DBFZ	German	Other	Standard	Sustainability indicators for Germany
50	Streamlined European Biodiversity Indicators	Biodiversity information system for Europe	2023	https://biodiversity.europa.eu/track/streamlined-european-biodiversity-indicators	DBFZ	English	European	Standard	EU indicators for biodiversity
51	Implementing of the EU Bioeconomy Monitoring System dashboards	Kilsedar, C et al.	2021	https://op.europa.eu/o/opportal-service/download-handler?identifier=4dd12863-7355-11ec-9136-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part=	DBFZ	English	European	Standard	It contains an overview of the purpose of the system, its current status and future outlook for 2022. Technical details of the back-end and

									front-end are also provided
52	Application of holistic and integrated LCSA: Case study on laminated veneer lumber production in Central Germany	Zeug, Walther, Alberto Bezama, & Daniela Thrän.	2022	https://link.springer.com/article/10.1007/s11367-022-02098-x	DBFZ	English	Other	Research	Holistic and integrated life cycle assessment (HILCSA) method containing indicators
53	Agriculture and bioeconomy Unlocking production potential in a sustainable and resource-efficient way	EIB	2018	https://www.eib.org/attachments/thematic/agriculture_and_bioeconomy_en.pdf	KIMITEC	English	European	Policy	EU loans and investments: “We finance projects across the agricultural, fisheries, food and forestry value chains"
54	Agriculture, bioeconomy and rural development. Overview	EIB	2021	https://www.eib.org/attachments/thematic/agriculture_bioeconomy_and_rural_development_overview_2021_en.pdf	KIMITEC	English	European	Policy	EU loans and investments
55	Characteristics of bioeconomy systems and sustainability issues at the territorial scale. A review	J.Wohlfahr, F.Ferchaud, B.Gabrielle, C.Godard, B.Kurek, C.Loyce, O.Therond,	2019	https://www.sciencedirect.com/science/article/abs/pii/S0959652619319274	KIMITEC	English	Global	Research	In this paper, based on a literature review, we highlight the complexity of bioeconomy systems and propose a framework to support their sustainable development.

56	A holistic sustainability assessment tool for bioenergy using the Global Bioenergy Partnership (GBEP) sustainability indicators. Biomass Bioenergy 66, 70e80.	Hayashi, T., van Ierland, E.C., Zhu, X., 2014.	2014	https://research.wur.nl/en/publications/a-holistic-sustainability-assessment-tool-for-bioenergy-using-the	KIMITEC	English	Global	Research	In 2011 the Global Bioenergy Partnership (GBEP) released a set of indicators for sustainable bioenergy.
57	The Partnership Platform	United Nations	2023	https://sdgs.un.org/partnerships	KIMITEC	English	Global	Standard	The Partnership Platform is a global registry of voluntary commitments and multi-stakeholder partnerships made by stakeholders in support of the implementation of the Sustainable Development Goals (SDGs), and through various UN conferences and thematic action networks
58	The environmental impacts of non-food biomass production through land-use changes: scope, foci and methodology of current research.	Gabrielle, B., Barbottin, A., Wohlfahrt, J., 2018.	2018	https://link.springer.com/chapter/10.1007/978-3-319-96289-4_3	KIMITEC	English	Global	Research	The analysis of multi-functional systems, integrating non-food and food production and value-chains should be fostered, along with interactions between the various research communities currently seeking to

									address the LUC-mediated impacts of the bio-based economy.
59	Bioeconomy and SDGs: Does the Bioeconomy Support the Achievement of the SDGs?	Tobias Heimann	2018	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018EF001014	KIMITEC	English	European	Research	This paper evaluates how bioeconomy activities, stated in the concepts of the European Union, Organisation for Economic Co-operation and Development, and the German government, potentially affect the targets of the Sustainable Development Goals (SDGs).
60	Six Collective Challenges for Sustainability of Almería Greenhouse Horticulture	Antonio J. Castro et al.	2019	https://www.mdpi.com/1660-4601/16/21/4097	KIMITEC	English	Other	Research	In order to illustrate the wicked social, economic and environmental challenges and processes to find transformative solutions, we focus on the largest concentration of greenhouses in the world located in the semi-arid coastal

									plain of South-east Spain
61	Bioeconomy and Global Inequalities	Maria Backhouse, Rosa Lehmann, Kristina Lorenzen, Malte Lühmann, Janina Puder, Fabricio Rodríguez, Anne Tittor (2021)	2021	https://link.springer.com/book/10.1007/978-3-030-68944-5	KIMITEC	English	Global	Research	
62	Estrategia española de Bioeconomía Horizonte 2030	Ministerio de Economía y Competitividad	2015	https://www.mapa.gob.es/es/desarrollo-rural/temas/innovacion-medio-rural/estrategiaenbioeconomia23_12_15_tcm30-560119.pdf	Spanish Co-ops	Spanish	Other	Strategy	
63	Plan de Recuperación, Transformación y Resiliencia	Gobierno de España	2021	https://www.lamoncloa.gob.es/temas/fondos-recuperacion/Documents/160621-Plan_Recuperacion_Transformacion_Resiliencia.pdf	Spanish Co-ops	Spanish	Other	Policy	
64	Jobs and Wealth in the European Union	JRC	2022	https://datam.jrc.ec.europa.eu/datam/mashup/BI	Spanish Co-ops	English	EU	Research	

	Bioeconomy (Biomass producing and converting sectors)			OECONOMICS/index.html					
65	Plan Nacional de Adaptación al Cambio Climático 2021-2030	Ministerio para la Transición Ecológica y el Reto Demográfico	2020	https://www.miteco.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/pnacc-2021-2030_tcm30-512163.pdf	Spanish Co-ops	Spanish	Other	Strategy	
66	Emisiones de gases de efecto invernadero en el sistema agroalimentario y huella de carbono de la alimentación en España	Real Academia de Ingeniería	2020	https://www.raing.es/pdf/publicaciones/libros/emisiones_de_gases_efecto_invernadero.pdf	Spanish Co-ops	Spanish	Other	Research	
67	Plan Nacional Integrado de Energía y Clima (PNIEC) 2021-2030	Ministerio para la Transición Ecológica y el Reto Demográfico	2020	https://www.miteco.gob.es/images/es/pnieccompleto_tcm30-508410.pdf	Spanish Co-ops	Spanish	Other	Strategy	
68	Estrategia Española de Economía Circular	Ministerio para la Transición Ecológica y el Reto Demográfico	2020	https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/economia-circular/espanacircular2030_def1_tcm30-509532_mod_tcm30-509532.pdf	Spanish Co-ops	Spanish	Other	Strategy	
69	Agenda Estratégica de Investigación e Innovación del sector español de la Biomasa y la Bioeconomía (2020)	BIOPLAT	2020	https://bioplat.org/portfolio-items/agenda-estrategica-de-investigacion-e-innovacion-del-sector-espanol-de-la-biomasa-y-la-bioeconomia-2020/	Spanish Co-ops	Spanish	Other	Strategy	

70	Communication from the Commission: Towards a strong and sustainable EU algae sector	Directorate-General for Maritime Affairs and Fisheries	2022	https://oceans-and-fisheries.ec.europa.eu/publications/communication-commission-towards-strong-and-sustainable-eu-algae-sector_en	Spanish Co-ops	English	EU	Strategy	
71	Hoja de Ruta del Biogás	Ministerio para la Transición Ecológica y el Reto Demográfico	2022	https://energia.gob.es/es-es/Novedades/Documents/00HR_Biogas_V6.pdf	Spanish Co-ops	Spanish	Other	Policy	
72	PERTE en Economía Circular	Gobierno de España	2022	https://planderecuperacion.gob.es/sites/default/files/2022-03/PERTE_EC_memoria_09032022.PDF	Spanish Co-ops	Spanish	Other	Policy	
73	Indicadores de sostenibilidad en el sector agroalimentario	Universidad Politécnica de España	2022	https://ceigram.upm.es/wp-content/uploads/2022/10/Informe74-Indicadores-sostenibilidad.pdf	Spanish Co-ops	Spanish	Other	Research	
74	Zirkuläre Bioökonomie für Deutschland	Fraunhofer-Gesellschaft	2022	https://www.fraunhofer.de/content/dam/zv/de/forschung/FSF/biooekonomie/Fraunhofer_Roadmap_Biooekon76omie.pdf	DBFZ	German	Other	Strategy	
75	Camelina sativa. Status quo and future perspectives	Sydor M., Kurasiak-Popowska D., Stuper-Szablewska K., Rogoziński T.	2022	ttp://www.sciencedirect.com/science/article/pii/S0926669022010147	PULS	English	Global	Research	

76	Management of post-production wood waste in the aspect of circular economy	Magdalena, Janiszewska Dominika, Wróblewska Hanna, Stuper-Szablewska Kinga.	2021	http://wulsannals.com/resources/html/article/details?id=225849	PULS	English	Global	Research	The aim of this study was to characterize the wood raw material (wood waste as a by-product) and qualify it for the composting process on the basis of its composition.
77	Indicators for monitoring circular economy in Poland	Mineral and Energy Economy Research Institute of the Polish Academy of Sciences	2020	https://circulareconomy.europa.eu/platform/sites/default/files/ksiazka_goz_fin.pdf	PULS	English	Global	Strategy	
78	Serbia and Agenda 2030 Mapping the national strategic framework in relation to the goals of sustainable development	Public Policy Secretariat, Government of the Republic of Serbia	2018	https://sdgs4all.rs/wp-content/uploads/2022/06/SDG_Serbia_EU27_Region_08062022.pdf	IFVCNS	Serbian	Other	Other	
79	The Smart Specialization Strategy in the Republic of Serbia from 2020 TO 2027	Government of the Republic of Serbia	2020	https://www.srbija.gov.rs/extfile/sr/447675/strategija_pametne_specijalizacije215_lat2.zip	IFVCNS	Serbian	Other	Strategy	A document created with the aim of further social and economic development by increasing the competitiveness of the economy, economic growth and progress of society through the connection of research, industrial

									and innovation forces and resources. This document identifies priority areas in which further investment is needed: information and communication technologies; food for the future; machines and production processes of the future and creative industries.
80	The Circular Economy Roadmap of Serbia	Ministry of Environmental Protection of the Republic of Serbia	2020	https://circulareconomy.europa.eu/platform/sites/default/files/roadmap-for-circular-economy-in-serbia.pdf	IFVCNS	Serbian	Other	Other	
81	Agriculture and rural development strategy of the Republic of Serbia for the period 2014-2024		2014	http://www.minpolj.gov.rs/download/strategija-poljoprivrede-i-ruralnog-razvoja-republike-srbije-za-period-2014-2024-godine/	IFVCNS	Serbian	Other	Strategy	Defines goals for: achieving technological development and modernization of agricultural production and processing through the improvement of technology and a more efficient system of transferring experience and

									innovation; increasing productivity and efficiency in production at all levels in the food production chain; strengthening the ability of the food industry to create more value-added products with the use of domestic raw materials.
82	The Waste Management Program in the Republic of Serbia	Government of the Republic of Serbia	2018	https://www.ekologija.gov.rs/dokumenta/upravljanje-otpadom/program	IFVCNS	Serbian	Other	Strategy	
83	Road Map for circular economy in Serbia	MINISTRY OF ENVIRONMENTAL PROTECTION OF THE REPUBLIC OF SERBIA	2020	https://www.undp.org/serbia/publications/roadmap-circular-economy-serbia	IFVCNS	Serbian	Other	Other	
84	A platform for Serbia’s development priorities within the objectives of the 2030 Agenda for Sustainable Development	The “SDGs for All” Platform is supported by the Governments of Switzerland and Germany	2022	https://sdgs4all.rs/en/documents/	IFVCNS	English	Other	Other	The platform is structured in three pillars corresponding to the three dimensions of sustainable development: social, economic and environmental, but from the overall

									management perspective, it is operated in an integrated manner, recognizing that the SDGs and targets are closely interlinked.
85	Ex ante analysis of effects for the field of circular economy	Ministry of European Integration, Republic of Serbia	2020	https://www.ekologija.gov.rs/saopstenja/vesti/izvestaj-o-sprovedenoj-ex-ante-analiza-efekata-za-oblast-cirkularne-ekonomije	IFVCNS	English	Other	Other	
86	National strategy on the sustainable use of natural resources and goods	Government of the Republic of Serbia	2012	n/a	IFVCNS	Serbian	Other	Strategy	
87	The Green Agenda for the Western Balkans	European Comission	2020	https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwivkrSVjuX7AhWp7rsIHYLVB-AQFnoECBoQAQ&url=https%3A%2F%2Fneighbourhood-enlargement.ec.europa.eu%2Fsystem%2Ffiles%2F2020-10%2Fgreen_agenda_for_the_western_balkans_en.pdf&usg=AOvVaw3a5M50sUWNUBb4EmLK3frc	IFVCNS	English	Other	Strategy	

88	Circular economy action plan	European Comission	2020	https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en	IFVCNS	English	European	Strategy	
89	Consumer response to bio-based products – A systematic review	Ruf, Julia, Agnes Emberger-Klein, and Klaus Menrad.	2022	https://doi.org/10.1016/j.spc.2022.09.022	IFVCNS	English	European	Research	
90	Guidelines for Social Life Cycle Assessment of Products and Organisations	UNEP/SETAC Life Cycle Initiative	2020	https://www.lifecycleinitiative.org/wp-content/uploads/2021/01/Guidelines-for-Social-Life-Cycle-Assessment-of-Products-and-Organizations-2020-22.1.21sml.pdf	UNIBO	English	Global	Standard	
91	Environmental Life Cycle Costing	Hunkeler et al.		https://www.taylorfrancis.com/books/mono/10.1201/9781420054736/environmental-life-cycle-costing-david-hunkeler-kerstin-lichtenvort-gerald-rebitzer	UNIBO	English	Global	Standard	
92	Life Cycle Sustainability Assessment: What Is It and What Are Its Challenges?	Guinée Jeroen	2016	https://www.researchgate.net/publication/301264759_Life_Cycle_Sustainability_Assessment_What_Is_It_and_What_Are_Its_Challenges	UNIBO	English	Global	Research	
93	Towards a life cycle sustainability assessment making informed choices on products	UNEP/SETAC Life Cycle Initiative	2011	https://www.lifecycleinitiative.org/wp-content/uploads/2012/12/2011%20-	UNIBO	English	Global	Standard	

				%20Towards%20LCSA.pdf					
94	Social LCA Researcher School Book Social evaluation of the life cycle,application to the agriculture and agri-food sectors	Macombe Catherine	2016	https://www.fruitrop.com/media/Publications/FruiTrop-Thema/ACV-Sociale-volume-3	UNIBO	English	Other	Research	
95	Perspectives on Social LCA Contributions from the 6th International Conference: Contributions from the 6th International Conference	Petti et al.	2020	https://www.researchgate.net/publication/338304814_Perspectives_on_Social_LCA_Contributions_from_the_6th_International_Conference_Contributions_from_the_6th_International_Conference	UNIBO	English	Global	Standard	
96	Towards a more holistic sustainability assessment framework for agro-bioenergy systems — A review	Arodudu, O.; Helming, K.; Wiggering, H.; Voinov, A.	2017	https://www.sciencedirect.com/science/article/abs/pii/S0195925516300944	UNIBO	English	Global	Research	
97	Bridging the gap between LCA, LCC and CBA as sustainability assessment tools	Rob Hoogmartens, Steven Van Passel, Karel Van Acker, Maarten Dubois	2014	https://www.sciencedirect.com/science/article/abs/pii/S0195925514000481?via%3Dihub	UNIBO	English	Global	Research	
98	Growing better: Ten critical transitions to transform food and land use	The food and land use coalition	2019	https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf	UNIBO	English	Global	Strategy	

99	Mapping the sustainability of bioenergy to maximise benefits, mitigate risks and drive progress toward the Sustainable Development Goals	Welfle, A.; Roder, M.	2022	https://www.sciencedirect.com/science/article/pii/S0960148122004463	UNIBO	English	Global	Research	bio-energy and bioeconomy sustainability mapping framework
100	Effective sustainability criteria for bioenergy: Towards the implementation of the European renewable directive II	T. Mai-Moulin; R. Hoefnagels; P. Grundmann; M. Junginger	2021	https://www.sciencedirect.com/science/article/pii/S1364032120309291	UNIBO	English	European	Research	sustainability criteria
101	Mapping Social Impact Assessment Models: A Literature Overview for a Future Research Agenda	Corvo, L.; Pastore, L.; Manti, A.; Iannaci, D.	2021	https://www.mdpi.com/2071-1050/13/9/4750	UNIBO	English	Global	Research	
102	Sustainability assessment of small dairy farms from the main cattle farming systems in the North of Tunisia	Reali, M. & Malorgio, G.	2021	https://newmedit.iamb.it/bup/wp-content/uploads/2021/09/m_Sustainability-assessment-of-small-dairy-farms-from-the-main-cattle-farming-systems-in-the-North-of-Tunisia.pdf	UNIBO	English	Other	Research	
103	The future of the Mediterranean agri-food systems: Trends and perspectives from a Delphi survey	Antonelli, A.; Basile, L.; Gagliardi, F.; Isernia, P.	2022	https://www.sciencedirect.com/science/article/pii/S0264837722002903	UNIBO	English	Other	Research	transition priorities in Mediterranean agri-food systems
104	Social Impact and Sustainability in short food supply chains: an experimental assessment tool.	Corvo, L.; Pastore, L.; Antonelli, A.; Petruzzella, D.	2021	https://scholar.google.com/citations?view_op=view_citation&hl=it&user=PKzEFf8AAAAJ&citation_for_view=PKzEFf8AAAAJ:Wp0gIr-vW9MC	UNIBO	English	Other	Research	

105	Innovation and Sustainability of Agri-Food System in the Mediterranean Area	New Medit Special issue	2021	https://www.researchgate.net/profile/Larbi-Toumi/publication/355171310_SPECIAL_ISSUE_Innovation_and_Sustainability_of_Agri-Food_System_in_the_Mediterranean_Area/links/6163faa30bf51d48176ca309/SPECIAL-ISSUE-Innovation-and-Sustainability-of-Agri-Food-System-in-the-Mediterranean-Area.pdf?origin=publication_detail	UNIBO	English	Other	Standard	
106	A roadmap for sustainability performance assessment in the context of Agri-Food Supply Chain	Mafalda Ivo de Carvalho Susana Relvas Ana P.Barbosa-Póvoa	2022	https://www.sciencedirect.com/science/article/abs/pii/S235255092200269X	UNIBO	English	Global	Research	
107	Development of sustainability indicator scoring (SIS) for the food supply chain	Louise Manning and Jan Mei Soon	2016	https://www.emerald.com/insight/content/doi/10.1108/BFJ-01-2016-0007/full/pdf?casa_token=cG4_4cIEnd0AAAAA:eWCJhOPhT2itc5HVN--L5IkKQbHBVxlR0gii5OUuNHX3g6dQVrl8WI_bbcai5sE0fS2cFKls674JLxM-_pEikkYMqPtn013_7V6TxDL7SAZyMXyvpGI	UNIBO	English	Global	Research	sustainability indicators and framework development

108	Viewpoint: Rigorous monitoring is necessary to guide food system transformation in the countdown to the 2030 global goals	Fanzo et al.	2021	https://www.sciencedirect.com/science/article/pii/S0306919221001433	UNIBO	English	Global	Policy	
109	A Revision of What Life Cycle Sustainability Assessment Should Entail: Towards Modeling the Net Impact on Human Well-Being	Thomas Schaubroeck ,Benedetto Rugani	2017	https://onlinelibrary.wiley.com/doi/10.1111/jiec.12653	UNIBO	English	Global	Research	
110	Evaluation of sustainable innovations in olive growing systems: A Life Cycle Sustainability Assessment case study in southern Italy	De Luca et al.	2018	https://www.sciencedirect.com/science/article/pii/S0959652617324186	UNIBO	English	Other	Research	
111	Social sustainability tools and indicators for the food supply chain: A systematic literature review	E.Desiderio, L.García-Herrero, D.Hall, A.Segrè, M.Vittuari	2022	https://www.sciencedirect.com/science/article/pii/S2352550921003626	UNIBO	English	Global	Research	
112	Co-creating sustainability indicators for the local water–energy–food nexus	Moreira et al.	2022	https://link.springer.com/article/10.1007/s11625-022-01141-y	UNIBO	English	Global	Research	
113	Economic and Environmental Sustainability of Vegetative Oil Extraction Strategies at Integrated Oilcane and Oil-Sorghum Biorefineries	Cortés-Peña et al.	2022	https://pubs.acs.org/doi/pdf/10.1021/acssuschemeng.2c04204?src=getftr	UNIBO	English	Other	Research	

114	Break-even price and carbon emissions of carinata-based sustainable aviation fuel production in the South-eastern United States	Alam et al.	2021	https://www.scopus.com/record/display.uri?eid=2-s2.0-85114089241&origin=resultslist&sort=plf-f&src=s&st1=%28%22Life+Cycle+Thinking%22+OR+%22Life+Cycle+Sustainability+Assessment%22+OR+%22Life+Cycle+Assessment%22+OR+%22Life+Cycle+Costing%22+OR+%22Social+Life+Cycle+Assessment%22%29+AND+%28%22oilseed+crop*%22+OR+%22carinata%22%29&sid=ba28de009d529d54c25caa156901bdab&sot=b&sdt=b&sl=201&s=TITLE-ABS-KEY%28%28%22Life+Cycle+Thinking%22+OR+%22Life+Cycle+Sustainability+Assessment%22+OR+%22Life+Cycle+Assessment%22+OR+%22Life+Cycle+Costing%22+OR+%22Social+Life+Cycle+Assessment%22%29+AND+%28%22oilseed+crop*%22+OR+%22carinata%22%29%29&relpos=6&citeCnt=6&searchTerm=	UNIBO	English	Other	Research	

115	Contribution of LCA to decision making: A scenario analysis in territorial agricultural production systems	Borghino et al.	2021	https://www.sciencedirect.com/science/article/pii/S0301479721003509?via%3Dihub	UNIBO	English	Other	Research	
116	EU Bioeconomy Monitoring System indicator update 2021	Melim-Mcleod, C. et al.	2021	https://publications.jrc.ec.europa.eu/repository/handle/JRC128054	UNIBO	English	European	Policy	
117	Environmental sustainability assessment of bioeconomy value chains	Cristòbal J et al.,	2016	https://www.sciencedirect.com/science/article/pii/S096195341630023X	UNIBO	English	Other	Research	
118	Methodological framework to develop life cycle thinking assessment on 4CE-MED systems	Laura Brenes-Peralta (UNIBO), Edoardo Desiderio (UNIBO), Coraline Dessienne (ARVALIS), Sylvain Marsac (ARVALIS), Sripada M. Udupa (ICARDA), Abderrahmane Hannachi (INRAA); Matteo Vittuari (UNIBO)	2020	https://cris.unibo.it/retrieve/handle/11585/846366/e1dcb338-eef0-7715-e053-1705fe0a6cc9/4CEMED_D4.1_methodological-framework.pdf	UNIBO	English	Other	Other	This deliverable includes a literature review of papers applying life cycle methodologies on oilseed crops (mainly camelina)
119	Environmental life cycle assessment of bioethanol	Borrion et al.	2012	http://dx.doi.org/10.1016/j.biombioe.2012.10.017	UNIBO	English	Other	Research	

	production from wheat straw								
120	Second generation bioethanol production from Arundo donax biomass: an optimization method	Brusca et al.	2018	https://www.sciencedirect.com/science/article/pii/S1876610218304363	UNIBO		Other	Research	
121	Uncertainty in life cycle greenhouse gas emissions of sustainable aviation fuels from vegetable oils	Gonca et al.	2022	https://www.sciencedirect.com/science/article/pii/S1364032122008267?pes=vor	UNIBO	English	Other	Research	
122	On quantifying sources of uncertainty in the carbon footprint of biofuels: crop/feedstock, LCA modelling approach, land-use change, and GHG metrics	Brandao et al.	2022	https://www.biofueljournal.com/article_148830_cfd95668b16943c4b53ed4b7e16977ce.pdf	UNIBO	English	Other	Research	
123	Environmental and techno-economic analyses of bio-jet fuel produced from jatropha and castor oilseeds in China	Liu et al.	2021	https://www.scopus.com/redirect/linking.uri?targetURL=https%3a%2f%2fdoi.org%2f10.1007%2fs11367-021-01914-0&locationID=1&categoryID=4&eid=2-s2.0-85104847744&issn=09483349&linkType=ViewAtPublisher&year=2021&origin=recordpage&dig=9101fcf3f83b42a18a7da66b12d006fb	UNIBO	English	Other	Research	
124	Circular economy indicators: What do they measure?	Gustavo Moraga et al.	2019	https://www.sciencedirect.com/science/article/pii/S092134491930151X?via%3Dihub	UNIBO	English	Other	Research	

125	An aggregation framework to link indicators associated with multifunctional land use to the stakeholder evaluation of policy options	Paracchini, M. L., Pacini, C., Jones, M. L. M., & Pérez-Soba, M.	2011	https://www.sciencedirect.com/science/article/pii/S1470160X09000624?via%3Dihub	UNIBO	English	Other	Research	
126	Circular economy implementation in the agricultural sector: Definition, strategies and indicators	Juan F. Velasco-Mu˜noz et al.	2021	https://www.sciencedirect.com/science/article/pii/S0921344921002275?via%3Dihub	UNIBO	English	Other	Research	
127	The Sustainability Assessment of Plantation Agriculture - A Systematic Review of Sustainability Indicators	Dinish Nadaraja et al.	2021	https://www.sciencedirect.com/science/article/pii/S235255092031441X?via%3Dihub	UNIBO	English	Other	Research	
128	Transitioning towards the bio-economy: Assessing the social dimension through a stakeholder lens	Pasquale Marcello Falcone	2019	https://onlinelibrary.wiley.com/doi/10.1002/csr.1791	UNIBO	English	Other	Research	
129	FoodE D2.2 Methodological Framework to develop Life Cycle	Fabio De Menna, Martí Rufí-Salís, Mara Petruzzelli, Luuk Graamans, Francesco Cirone, Emanuele Durante, Pietro Tonini, Antonella Samoggia, Kathrin	2021	https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS	UNIBO	English	European	Research	

		Specht, Runrid FoxKämper, Agnès Lelièvre, Giovanni Bazzocchi, Josè PascualFernández, Ilaria Braschi, Xavier Gabarrell Durany, Matteo Vittuar							
130	Fit4Reuse D7.1 Safe and sustainable solutions for the integrated use of nonconventional water resources in the Mediterranean agricultural sector	Laura García Herrero Rémi Declerq Edoardo Desiderio Laura Brenes Peralta Matteo Vittuari	2020	https://fit4reuse.org/wp-content/uploads/2019/12/FIT4REUSE_WP7_D7.1_final.pdf	UNIBO	English	European	Research	
131	Ermittlung wirtschaftlicher Kennzahlen und Indikatoren für ein Monitoring des Voranschreitens der Bioökonomie	ifo Zentrum für Energie, Klima und Ressourcen	2019	https://www.ifo.de/DocDL/ifo_Forschungsberichte_104_2019_Monitoring-Biooekonomie.pdf	DBFZ	German	European	Research	In the frame of the German bioeconomy strategy, this study contributes to build a scientific basis for the development of bioeconomy indicators

132	How big is the bioeconomy? Reflections from an economic perspective	European Commission	2020	https://publications.jrc.ec.europa.eu/repository/handle/JRC120324	DBFZ	English	European	Policy	Report on economic indicators, aiming at the inclusion of bio-based services derived from the symmetric input-output tables from the system of national accounts available from Eurostat.
133	Synthesis on bioeconomy monitoring systems in the EU Member States - indicators for monitoring the progress of bioeconomy	Lier et al.	2018	https://jukuri.luke.fi/handle/10024/542249	DBFZ	English	European	Research	Overview of the existing bioeconomy strategies, policies and indicators to monitor and assess the bioeconomy at EU MS state
134	Monitoring the transition towards a bioeconomy: A general framework and a specific indicator	Jander & Grundmann	2019	https://www.sciencedirect.com/science/article/abs/pii/S0959652619323789	DBFZ	English	Other	Research	Test of a bioeconomy monitoring framework and the application of a newly developed indicator: the Substitution Share Indicator (SSI)
135	Bioeconomy triple factor nexus through indicator analysis	Zihare et al.	2021	https://www.sciencedirect.com/science/article/pii/S1871678420301977	DBFZ	English	Other	Research	To develop a methodology for the assessment of bioeconomy-influencing factor interlinkages, and creation of benchmarks through

									a top-down approach
136	A New Socio-economic Indicator to Measure the Performance of Bioeconomy Sectors in Europe	D´adamo, Falcone and Morone	2020	https://www.sciencedirect.com/science/article/pii/S0921800919312273	DBFZ	English	European	Research	Proposition of a new socio-economic indicator for bioeconomy to measure the socio-economic performance of bioeconomy sectors
137	Development of the Circular Bioeconomy: Drivers and Indicators	Kardung et al.	2021	https://www.mdpi.com/2071-1050/13/1/413	DBFZ		European	Research	Analysis od driver factor for bioeconomy and a outlining of a set of indicators
138	Bioeconomy development factors in the European Union and Poland	Wozniak, Tyczewska & Twardowski	2021	https://www.sciencedirect.com/science/article/pii/S1871678420301643	DBFZ	English	European	Research	The study discusses factors for bioeconomy development through an analysis of their social, economic and environmental aspects.
139	Toward a systemic monitoring of the European bioeconomy: Gaps, needs and the integration of sustainability indicators and targets for global land use	O´ Brien et al.	2017	https://www.sciencedirect.com/science/article/abs/pii/S0264837716314053	DBFZ	English	European	Research	With a focus on the land dimension, this article examines the strengths and weakness of different economic, environmental and integrated models and methods for monitoring and forecasting the

									development of the EU bioeconomy
140	Bridging the Gaps for a ‘Circular’ Bioeconomy: Selection Criteria, Bio-Based Value Chain and Stakeholder Mapping	Lokesh, Ladu & Summerton	2018	https://www.mdpi.com/2071-1050/10/6/1695	DBFZ	English	Global	Research	Mapping of 2 bio-based value chains in EU MS
141	Farm-to-Fork strategy	UE	2020	https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf	ARVALIS	English	European	Policy	
142	Agribalyse	Ademe	2022	https://3613321239-files.gitbook.io/~/files/v0/b/gitbook-x-prod.appspot.com/o/spaces%2F-M7H-JTDnDsswmNDPy-z%2Fuploads%2FQSZZLOqH3JFbcGmN1d85%2FMethodology%20AGB%203.1_Food%20products-Main.pdf?alt=media&token=657b2352-01e9-45e0-9557-bc76e53bd1e7	ARVALIS	English	Other	Standard	Inventory, methodology and indicator for LCA

143	L'évaluation française des écosystèmes et des services écosystémiques	MTES	2022	https://www.ecologie.gouv.fr/levaluation-francaise-des-ecosystemes-et-des-services-ecosystemiques#:~:text=Dans%20son%20corps%2C%20le%20rapport%20d%C3%A9bute%20par%20une,transition%20%C3%A9cologique%20et%20solidaire%20de%20la%20soci%C3%A9t%C3%A9%20fran%C3%A7aise.	ARVALIS	French	Global	Research	Refrences of ecosystems and services, example of assessments carried on
144	Le projet agro-écologique :Vers des agricultures doublement performantes pour concilier compétitivité et respect de l'environnement	INRAE	2013	https://agriculture.gouv.fr/sites/default/files/documents/rapport_marion_guillou_cle05bdf5.pdf	ARVALIS	French	Other	Strategy	
145	Low carbon	MTE	2022	La méthode Grandes Cultures | Label bas carbone - Ministère de la transition énergétique (ecologie.gouv.fr)	ARVALIS	French	Other	Policy	Methodology for low carbon certification
146	RSB low iLUC risk biomass module	RSB	2015	https://rsb.org/rsb-low-iluc-module/	RSB	English	European	Standard	Methodology for low iLUC biomass
147	RSB standard for advanced products	RSB	2018	https://rsb.org/rsb-standard-for-advanced-products/	RSB	English	European	Standard	This Standard is for use by producers of non-energy products.
148	Industrial Emission Directive	European Commission	2010	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075	RSB	English	European	Policy	Directive 2010/75/EU of the European Parliament and of the Council of 24

									November 2010 on industrial emissions (integrated pollution prevention and control)
149	Regulation on Accounting Rules on GHGs Emissions and removals from LULUCF	European Commission	2018	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG	RSB	English	European	Policy	Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU
150	Sustainable Use of Pesticides	European Commission	2022	https://food.ec.europa.eu/system/files/2022-06/pesticides_sud_eval_2022_reg_2022-305_en.pdf	RSB	English	European	Policy	The proposal for the Sustainable Use of Pesticides contributes to the reducion of the EU's environmental footprint and the mitigation of economic losses due to climate change. Main

									measures include among others, (1) the set of legally binding targets to reduce the use of and risk of chemical pesticides, (2) ensure the use of Integrated Pest Management techniques, and (3) bann pesticides in sensitive areas
151	Sustainable Products Initiative	European Commission	2022	https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative_en	RSB	English	European	Policy	The purpose of the regulation is to set legal requirements to increase the sustainability of products, including resource efficiency, carbon neutrality, and information accessibility. In addition to focusing on product's durability, reusability, and repairability, ESPR also establishes requirements on transparency as a key element enabling circularity.

152	Sustainable Carbon Cycles Communication	European Commission	2021	https://climate.ec.europa.eu/system/files/2021-12/com_2021_800_en_0.pdf	RSB	English	European	Policy	The Communication on Sustainable Carbon Cycles is the first document of the European Commission that highlights the need for renewable and sustainable carbon in our economy. The objective of the initiative is to contribute to the target of the EU to become climate resilient by 2050. It highlights the potential and need for circularity in carbon cycles while also recognizing carbon accounting problems.
153	Proposal for a Regulation on an EU certification for carbon removals	European Commission	2022	https://climate.ec.europa.eu/system/files/2022-11/Proposal_for_a_Regulation_establishing_a_Union_certification_framework_for_carbon_removals.pdf	RSB	English	European	Policy	The EU carbon removal certification framework will ensure transparency, environmental integrity, and prevent negative impacts on biodiversity and ecosystems, especially concerning resource or energy-intensive

									industrial solutions. The objective is to provide assurance about the quality of the carbon removals and make the certification process reliable and trustworthy to combat greenwashing.
154	Exploring regional transitions to the bioeconomy using a socio-economic indicator: the case of Italy	D´adamo, Falcone and Morone	2022	https://www.sciencedirect.com/science/article/pii/S0921800919312273	DBFZ	English	European	Research	

4.2. List of preliminary Indicators

Table 8: Top-Down indicators for the economic dimension.

Cate gory	Name	Short description	Unit	Additional Reference
Econo mic	Investment in tangible goods ratio	ITG = Capital Investments / Total Expenses	%	https://www.sciencedirect.com/ science/article/pii/S1871678420301643 https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Gross_investment_in_tangible_goods_-_SBS
	Gross Margin (GM)	GM=Total Gross Revenue - Total Cost / Total Gross Revenue	%	https://www.sciencedirect.com/science/article/pii/S0959652617324186
	Net margin	NM= Total Net Revenue - Total Cost / Total Net Revenue	%	Systerre
	Gross turnover	GT = Total sales	€	https://publications.jrc.ec.europa.eu/r epository/handle/JRC120324
	Gross value added (GVA) per person	GVAp = Total Net Revenue - Total Cost / n of employees	€	https://www.emerald.com/insight/content/doi/10.1108/BFJ-01-2016-0007/full/pdf?casa_token=cG4_4cIEnd0AAAAA:eWCJhOPhT2itc5HVN--L5IkKQbHBVxlR0gii5OUuNHX3g6dQVrl8WI_bbcai5sE0fS2cFKls674JLxM-_pEikkYMqPtn013_7V6TxDL7SAZyMXyvpGI
	Gross value added	GVA = Total Net Revenue - Total Cost	€	https://research.wur.nl/en/publications/a-holistic-sustainability-assessment-tool-for-bioenergy-using-the https://www.sciencedirect.com/science/article/pii/S1871678420301643
	Net Present Value (NPV);	NPV = Cashflow / (1+i)^t I= discount rate T = time of the investment	€	https://www.sciencedirect.com/science/article/pii/S0959652617324186
	return on capital employed (ROCE %)	ROCE = EBIT / Total assets - Total Liabilities	%	https://www.emerald.com/insight/content/doi/10.1108/BFJ-01-2016-0007/full/pdf?casa_token=cG4_4cIEnd0AAAAA:eWCJhOPhT2itc5HVN--

				L5IkKQbHBVxlR0gii5OUuNHX3g6dQVrl8WI_bbcai5sE0fS2cFKls674JLxM-_pEikkYMqPtn013_7V6TxDL7SAZyMXyvpGI
	OPEX	OPEX = Total Operative Costs	€	https://wayback.archive-it.org/12090/20221203224508/https://ec.europa.eu/inea/sites/default/files/cba_guide_cohesion_policy.pdf
	CAPEX	OPEX = Total Capital Investments	€	https://wayback.archive-it.org/12090/20221203224508/https://ec.europa.eu/inea/sites/default/files/cba_guide_cohesion_policy.pdf
	Gross product	GP = Total sales	€	Systerre
	Economic efficiency of inputs	EII = GP - inputs / inputs	%	Systerre
	Return on Investment (ROI)	ROI = Total Benefits - Total Costs / Total Cost	%	https://wayback.archive-it.org/12090/20221203224508/https://ec.europa.eu/inea/sites/default/files/cba_guide_cohesion_policy.pdf
	Internal Rate of Return (IRR)	NPV = 0 = Cashflow / (1+IRR)^t	%	https://wayback.archive-it.org/12090/20221203224508/https://ec.europa.eu/inea/sites/default/files/cba_guide_cohesion_policy.pdf
	Break Even Point (BEP)	BEP is where Total Revenues / Fixed Costs = 1	%	https://wayback.archive-it.org/12090/20221203224508/https://ec.europa.eu/inea/sites/default/files/cba_guide_cohesion_policy.pdf
	Benefit Cost Ratio (BCR)	BCR = Total Benefits / Total Costs	%	https://wayback.archive-it.org/12090/20221203224508/https://ec.europa.eu/inea/sites/default/files/cba_guide_cohesion_policy.pdf
	Value-based resource efficiency (VRE)	VRE = Total outputs / Total Inputs x Weighting factor	%	https://www.sciencedirect.com/science/article/pii/S0921344917300447
	Cash Flow Ratio	CFR = Total Cashflow / Total Liabilities	%	https://www.sciencedirect.com/science/article/pii/S2352550921000609
	Fixed assets to Total Assets	Fixed assets to Total Assets	%	https://www.sciencedirect.com/science/article/pii/S2352550921000609
	Social Return of Investment	SROI = Total Internal and External Benefits - Total Internal and External Costs / Total Internal and External Benefits	%	https://www.emerald.com/insight/content/doi/10.1108/SEJ-12-2019-0098/full/html

Table 9: Top-Down indicators for the environmental dimension.

Category	Name	Short description	Unit	Additional Reference
Enviroment	Climate change	GHG emissions	g CO_2	Renewable energy directive II
	Water conservation	"Operations shall include a water management plan which aims to use water efficiently and to maintain or enhance the quality of the water resources that are used for the operations"		RSB Principles and Criteria
	Water conservation	"Operators shall develop and implement a water management plan and integrate it into the Environmental and Social Management Plan (ESMP).		RSB Principles and Criteria
	water conservation	Water saving practices-importance of having water saving practises		Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	Soil conservation	Increase of soil organic matter content due to soil managemnet practises		RSB Principles and Criteria
	water conservation	Wastewater or runoff that contains potential organic and mineral contaminants shall be treated or recycled to		RSB Principles and Criteria

		prevent any negative impact on humans, wildlife, and natural compartments (water, soil).		
	Air quality			
	waste management and circularity	Adoption of circularity practises egarding organic waste, reuse of production waste, reuse of production or other practises to lower process impact		Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	Carbon stock conservation			
	Land use type	there is no land use change (taking as reference January 2008)		Renewable energy directive II
	Biodiversity			
	Resource use efficiency	use of renewable energy during the process		Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	resource use efficiency	use of renewable energy during heat usage		Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	transport	type of transport used in each step of the process	degree of fossil fuel used or alternative fuels	Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	transport	Efficiency transport routes	Is there any guide on this?	

	LC energy demand	Cumulative energy demand	MJ	Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	Ecotoxicity	Terrestrial, freshwater and marine ecotoxicity	Kg 1,4-DB eq.	Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	Human toxicity	Human carcinogenic and non-carcinongenic	Kg 1,4-DB eq	Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	Eutrophication	Freshwater eutrophication	Kg P eq.	Fodde: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e4a103af&appId=PPGMS
	Contribution of recycled materials to raw materials demand	Circular material use rate	%	https://www.sciencedirect.com/science/article/pii/S092134491930151X?via%3Dihub

Table 10: Top-Down indicators for the social dimension

Category	Subcategory	Name	Short description	Unit	Additional Reference
Labour /Job	Working conditions	Average wages per person	Average wage PER HOUR per person for each category (supply chain stage) / national average wage per person for each category	€	https://www.emerald.com/insight/content/doi/10.1108/BFJ-01-2016-0007/full/pdf?casa_token=cG4_4cIEnd0AAAAA:eWCJhOPhT2itc5HVN--L5IkKQbHBVxlR0gii5OUuNHX3g6dQVrl8WI_bbcai5sE0fS2cFKls674JLxM-_pEikkYMqPtn013_7V6TxDL7SAZyMXyvpGI

		Estimated permanent work	Number of fixed-term contracts in % of the total number of contracts	%	https://www.fruitrop.com/media/Publications/FruiTrop-Thema/ACV-Sociale-volume-8
		Work-related risks	Hours of risk exposure	n/year	https://www.sciencedirect.com/science/article/pii/S0959652617324186
		Occupational health and safety	Number of occupational accidents per year	n/year	https://link.springer.com/content/pdf/10.1007/s11367-015-0877-8.pdf
		Working hours per week	working hours per week per person (relative to working hours per week as indicated in the contract)	n or %	https://onlinelibrary.wiley.com/doi/10.1002/csr.1791
	Labour rights	% disadvantaged workers	number of workers from vulnerable groups as % of the total number of workers	%	https://scholar.google.com/citations?view_op=view_citation&hl=it&user=PKzEFf8AAAAJ&citation_for_view=PKzEFf8AAAAJ:Wp0gIr-vW9MC
	Gender balance	Equal pay (Gender)	Gender wage gap - potentially to be compared to the national average	%	https://link.springer.com/article/10.1007/s11367-021-01983-1
		Equal opportunities	Rate of female employees (and rate of female employees in managerial position)	%	https://link.springer.com/article/10.1007/s11367-021-01983-1
		Measures to improve gender equality	existing/implemented measures to improve gender equality	Y/N	https://link.springer.com/article/10.1007/s11367-021-01983-1
	Job opportunities	Employment	Average number of employees	n	https://www.sciencedirect.com/science/article/pii/S1871678420301643

		Local employment	Number of local (from the region) employees hired, in % of the total number of employees hired	%	https://www.sciencedirect.com/science/article/pii/S2352550921003626
Local development	Economic development	income stabilisation	average income gap (of the last 3 years) between scenario a and b, where a is without cover crop and b is with cover crop	%/year	https://agrifoodecon.springeropen.com/articles/10.1186/s40100-019-0141-9
		Tax exemptions	% on total revenue of tax exemptions for aid-funded projects	%	
		Equal distribution of the generated value	Equity in distribution of generated value (or profit) among the FSC actors (i.e. how much of the profit is generated within each of the FSC stages) calculated as Gini index	%/year	https://scholar.google.com/citations?view_op=view_citation&hl=it&user=PKzEFf8AAAAJ&citation_for_view=PKzEFf8AAAAJ:Wp0gIr-vW9MC
	Education and knowledge transfer	Number of employees trained	number of employees trained as % of the total number of employees	%/year	https://www.emerald.com/insight/content/doi/10.1108/BFJ-01-2016-0007/full/pdf?casa_token=cG4_4cIEnd0AAAAA:eWCJhOPhT2itc5HVN--L5IkKQbHBVxlR0gii5OUuNHX3g6dQVrl8WI_bbcai5sE0fS2cFKls674JLxM-_pEikkYMqPtn013_7V6TxDL7SAZyMXyvpGI
		Training and re-qualification of the workforce		%/year	https://newmedit.iamb.it/bup/wp-content/uploads/2021/09/m_Sustainability-assessment-of-small-dairy-farms-from-the-main-cattle-farming-systems-in-the-North-of-Tunisia.pdf

Table 11: Top-Down integrated indicators

Category	Subcategory	Name	Short description	Unit	Additional Reference
Integration	Infrastructure	Infrastructure	Relevant infrastructures for CARINA concepts are, in order of relevance: roads, telecommunication, storage facilities, water plants, energy plants (Orozco et al.2021) but also pre-treatment, PHW extractor, biorefineries, labs for demonstration tests with carinata and camelina (demo tests are tasks in both WP1 & WP2). Infrastructure availability measures if such infrastructures are available at the territorial level where CARINA supply chains are going to be implemented.	Type and amount of infrastructure present at the supply chain level	* Supportive Business Environments to Develop Grass Bioeconomy in Europe, Orozco et al., 2021 , p.12629 https://mdpi-res.com/d_attachment/sustainability/sustainability-13-12629/article_deploy/sustainability-13-12629.pdf?version=1637034837 * Development of an integrated sustainability matrix to depict challenges and trade-offs of introducing bio-based plastics in the food packaging value chain, Gerassimidou et al. 2020, p.9 https://reader.elsevier.com/reader/sd/pii/S095965262035424X?token=F66F05B0B83FCD18019A81C7AD0137A024DBD9353B1234AE428B60D05A5AEE9125879C373836ABAE7C8A5D418E624CF6&originRegion=eu-west-1&originCreation=20230426073728 * Novel regional and landscape-based approaches to govern sustainability of bioenergy and biomaterials supply chains (Diaz-Chavez et al. 2020 p.46) https://www.ieabioenergy.com/wp-content/uploads/2020/07/Novel-regional-and-landscape-based-approaches-to-govern-sustainability-of-bioenergy-and-biomaterials-supply-chains.pdf
	Circularity	Circularity	Biomass that has been processed into a bio-based final product can be used at least once more either for material or energy purposes. Cascading use may be distinguished into: ‣ Single-stage cascade:	No. of uses of products	* Circular economy action plan https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN * Cascade Use and the Management of Product Lifecycles (Karvelkamp et al. 2017, p.1540) https://mdpi-res.com/d_attachment/sustainability/sustainability-09-01540/article_deploy/sustainability-09-01540-v2.pdf?version=1504085660 * Fehrenbach, Horst; Köppen, Susanne; Breitmayer, Elke; Essel, Roland; Baur, Frank; Kay, Sonja et al. (2017) More

			after material use, the bio-based final product is directly used for energy purposes ‣ Multi-stage cascade: the bio-based final product is used at least once more as a material" (Fehrenbach et al. 2017, p. 27). CARINA by-products can be processed into further uses such as energy or material use. So this indicator measures if and how many alternative options exist.		resource efficiency through material cascade use of biomass - from theory to practice. Edited by Umweltbundesamt (UBA) / Federal Environment Agency. https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2017-06-13_texte_53-2017_biokaskaden_summary.pdf
	Combination options	Combination options	Production of both material and energy, when using camelina and carinata.	dmnl/%	*Life cycle assessment of a Brassica carinata bioenergy cropping system in southern Europe (Gasol et al. 2007, p.549-550) https://www.sciencedirect.com/science/articlw/pii/S0961953407000566 * Production and trading of biomass for energy – An overview of the global status (Heinimo J.; Junginger M. 2009, p.1313,1319) https://www.sciencedirect.com/science/article/pii/S096195340900107X * About the Relationship Between Green Technology and Material Usage (Wendler, T., 2019, p.1385, 1407) https://link.springer.com/content/pdf/10.1007/s10640-019-00373-4.pdf?pdf=button * https://task40.ieabioenergy.com/wp-content/uploads/sites/29/2013/09/t40-cascading-2016.pdf
	Digitalisation	Digitalisation	Level of integration of applied digital concepts,	Amount and	* Project call: aims at less waste and more value by extending the lifetime and retaining the value of products and materials.

			e.g. smart concepts, KI, machine learning	efficiency of digital technologies used	* Digital Factory - Integration Of Simulation From Product And Production Planning Towards Operative Control (Kühn, Wolfgang 2006, p. 2-3) https://www.scs-europe.net/services/ecms2006/ecms2006%20pdf/59-ibs.pdf * Project: DIGIBIO - Digitalisation of biomass energy recovery processes with high added value (European Cluster Collaboration 2021) https://clustercollaboration.eu/community-news/project-digibio-digitalisation-biomass-energy-recovery-processes-high-added * Framework: Recommendations for implementing the strategic initiative INDUSTRIE 4.0. (Kagermann, H. et al., 2013 p. 6-7, 16, 20) https://www.din.de/blob/76902/e8cac883f42bf28536e7e8165993f1fd/recommendations-for-implementing-industry-4-0-data.pdf
	Flexibility	Flexibility	Adaptability and versatility of the plant design to be used across systems.	Adaptability capacity	* A review on manufacturing flexibility (Jain, A., et al. 2013 p.5948-5951) https://www.tandfonline.com/doi/epdf/10.1080/00207543.2013.824627?needAccess=true&role=button * Five cornerstones to unlock the potential of flexible bioenergy (Thrän, D., et al., 2021, p.3-4) https://www.ieabioenergy.com/wp-content/uploads/2021/12/IEA-Bioenergy-Task-44-Five-cornerstones-to-unlock-the-potential-of-flexible-bioenergy.pdf
	Modularity	Modularity	Ability, compatibility and capacity of CARINA concepts to be seperated in interchangeable modular components that can be recombined, reconfigured or replaced within systems and subsystems. Cohesion describes the concept relation and focus on specific tasks of	Modularity level based on Cohesion, Coupling and Connascence	* Cradle-to-gate assessment of environmental impacts for a broad set of biomass-to-product process chains (Karka, P. et al. 2017, p.1422, 1428) https://link.springer.com/article/10.1007/s11367-017-1262-6#citeas * Development of the Integrated Biomass Supply Analysis and Logistics Model (IBSAL) (Sokhansanj, S. et al. 2008, p.2) https://info.ornl.gov/sites/publications/files/Pub10657.pdf * Modularity measures: Concepts, computation, and applications to manufacturing systems (Shao, Y.; Zavala, M., 2020, p.1-2) https://aiche.onlinelibrary.wiley.com/doi/10.1002/aic.16965 * Measuring coupling and cohesion of software modules: an

			the modules. Coupling describes the intramodular dependacy of modules. Connascence describes the degree of shared knowledge, assuptions and dependencies of modules.		information-theory approach (Allen, E.B., et al., 2001, p.1-2) https://www.sdml.cs.kent.edu/library/Allen99.pdf
	Readiness level	Readiness level	This indicator measures the technological development of a specific technology. (ORIZON 2020 – WORK PROGRAMME 2014-2015 General Annexes, TRL).	TRL unit	* Vik, J., Melås, A. M., Stræte, E. P., & Søraa, R. A. (2021). Balanced readiness level assessment (BRLa): A tool for exploring new and emerging technologies. Technological Forecasting and Social Change, 169, 120854 p. 5
	Readiness level	Readiness level	This indicator is about the commodification of a technology and it addresses how well-developed is the process of adapting the product to the market.	MRL unit	* Vik, J., Melås, A. M., Stræte, E. P., & Søraa, R. A. (2021). Balanced readiness level assessment (BRLa): A tool for exploring new and emerging technologies. Technological Forecasting and Social Change, 169, 120854 p. 5
	Co-benefits	Co-benefits	Additional co-benefits, e.g. enhance knowledge, diversification, added value (valorization), waste reduction, spillovers from other process chains	Quality and quantity of co-benefits	* Climate policy co-benefits: a review (Karlsson, M., 2020, p. 301) https://www.tandfonline.com/doi/full/10.1080/14693062.2020.1724070

4.3. List of Bottom-Up Indicators

Table 12: Bottom-Up indicators for the economic dimension.

Indicator	Unit
Gross Margin (GM)	%
Total Gross Revenue - Total Cost / Total Gross Revenue	
Net Margin	%
Total Net Revenue - Total Cost / Total Gross Revenue	
Gross Turnover (GT)	€
Total sales	
Gross value added per person (GVAp)	€
Total Net Revenue - Total Cost / n of employees	
Gross Value Added (GVA)	€
Total Net Revenue - Total Cost	
Operational expenditures (OPEX)	€
Total Operative Costs	
Economic Efficiency of inputs (EEI)	%
(Gross Product - inputs) / inputs	
Return on Investment (ROI)	%
(Total Benefits - Total Costs) / Total Cost	
Break even point (BEP)	%
Total Revenues/Fixed Costs=1	
Benefit Cost Ratio (BCR)	%
Total Benefits / Total Costs	

Table 13: Bottom-Up indicators for the environmental dimension.

Indicator	Unit
GHGs Emissions	g CO_2
CO_2 emissions	
Water availability	High, medium, low risk
Operations are in a region with medium, high or extremely water stress	
Water management	Yes/No
Implementation of water management plan. The water management plan (both for rain-fed and irrigated crops) shall contain good water management practices to optimise water use	
Water saving	Yes/No
Implementation of water saving practices	
Water depletion	Yes/No
Operations affect the depletion of surface or groundwater resources below replenishment capacities	
Water quality	Yes/No
Wastewater or runoff that contains potential organic and mineral contaminants shall be treated or recycled to prevent any negative impact on humans, wildlife, and natural compartments (water, soil)	
Deforestation risk	High, medium, low risk
Risk of forest decrease in the area where crop is located	

Soil quality	Yes/No
Measures to improve soil health are put into place: direct seeding, maintenance of soil cover, crop rotation	
Soil Conservation	Organic matter content measure (>1%)
Increase of soil organic matter content due to soil management practises	
Biodiversity conservation	Yes/No
Ecological corridors are protected, restored or created to minimize habitat fragmentation	

Table 14: Bottom-Up indicators for the social dimension.

Indicator	Unit
Average wages per person	€
Average wage per hour per person for each category (supply chain stage) / national average wage per person for each category	
Working hours per week	N or %
Working hours per week per person (relative to working hours per week as indicated in the contract)	
Equal pay (gender)	%
Gender wage gap - potentially to be compared to the national average	
Equal opportunities	N
Rate of female employees (and rate of female employees in managerial position)	
Measures to improve gender equality	Yes/No
Existing/implemented measures to improve gender equality	

Local employment Number of local (from the region) employees hired, in % of the total number of employees hired	%
Income stabilisation Average income gap (of the last 3 years) between scenario a and b, where a is without cover crop and b is with cover crop	%/year
Equal Distribution of the generated value Equity in distribution of generated value (or profit) among the FSC actors (i.e. how much of the profit is generated within each of the FSC stages) calculated as Gini index	%/year
Number of employees trained Number of employees trained as % of the total number of employees	%/year
Training and re-qualification of the workforce Number of people belonging to the workforce trained and/or requalified	%/year

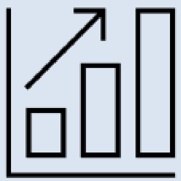
Table 15: Bottom-Up integrated indicators.

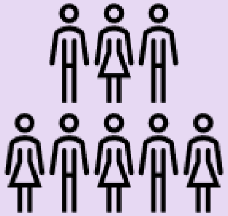
Indicator	Unit
Cascading options Describes the possibility of subsequent use of accruing non-product material for material and energy i.e. cascade use	Y/N secondary material use for energy or material utilization/no further use and must be disposed of
Production efficiency Describes how efficient biomass is used and thus production is. Determines the amount and use of original feedstock in the target product and how much is lost as unused biomass outside of the product	% used of the original biomass in kg with purpose

Systematic circular incentives	% of financial incentive for circular implementation
Describes the likeliness to develop circular systems based on incentives e.g. holistic framework, policies, sustainable demands in circularity (value-creation, competiveness, risk reduction)	
Combination options	% material/energy production
The indicator checks whether the production of both material and energy when using camelina and carinata is possible e.g. optimized interrelationship	
Innovation potential	Degree of novelty, uniqueness, influence of further development
Describes the distance of an innovation compared to previous solutions. Relative value to describe the state of understanding at the time	
Technology Readiness Level (TRL)	TRL unit
This indicator measures the technological development of a specific technology	
Market Readiness Level (MRL)	MRL unit
This indicator is about the commodification of a technology, and it addresses how well-developed is the process of adapting the product to the market	
Regional added value	Quality and quantity of added value on a regional level
The amount of value (quality & quantity) created and added to the regional level compared to the status quo. The regional value-added increases with the number of actors involved in the value chain and thus the full utilization of existing regional concepts	
Flexibility of the design	Adaptability capacity of the design
Adaptability and versatility of the plant design system to be used across systems. Based on integration, acceptance of changing feedstocks, scaling, modification and adjustments of the design	
Co-benefits	Quantity of co-benefits (N)
Additional co-benefits, e.g. enhance knowledge, diversification, added value (valorisation), waste reduction, spillovers from other process chains	

4.4. Synthesis

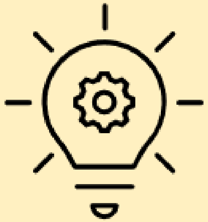
Table 16: Synthesis indicators.

Category	Subcategory	Name	Description	Unit	Calculation clarified
Economic 		Gross Margin (GM)	GM=Total Gross Revenue - Total Cost / Total Gross Revenue	%	Confirmed
		Net margin (NM)	NM= Total Net Revenue - Total Cost / Total Net Revenue	%	Confirmed
		Gross turnover (GT)	GT = Total sales	€	Confirmed
		Gross value added per person (GVAp)	GVAp = Total Net Revenue - Total Cost / n of employees	€	Confirmed
		Gross value added (GVA)	GVA = Total Net Revenue - Total Cost	€	Confirmed
		Total Operative Costs (OPEX)	OPEX = Total Operative Costs	€	Confirmed
		Economic efficiency of inputs (EII)	EII = GP - inputs / inputs	%	Confirmed
		Return on Investment (ROI)	ROI = Total Benefits - Total Costs / Total Cost	%	Confirmed
		Break Even Point (BEP)	BEP is where Total Revenues / Fixed Costs = 1	%	Confirmed

		Benefit Cost Ratio (BCR)	BCR = Total Benefits / Total Costs	%	Confirmed
Social 	Working conditions	Average wages per person	Average wage per hour per person for each category (supply chain stage) / national average wage per person for each category	€	Confirmed
	Working conditions	working hours per week	Working hours per week per person (relative to working hours per week as indicated in the contract)	n or %	Confirmed
	Gender balance	equal pay	Gender wage gap - potentially to be compared to the national average	%	Confirmed
	Gender balance	equal opportunities	Rate of female employees (and rate of female employees in managerial position)	%	Confirmed
	Gender balance	measures to improve gender equality	Existing/implemented measures to improve gender equality	Y/N	Confirmed
	Economic development	Local employment	Number of local (from the region) employees hired, in % of the total number of employees hired	%	Pending

	Economic development	income stabilisation	Average income gap (of the last 3 years) between scenario a and b, where a is without cover crop and b is with cover crop	%/year	Confirmed
	Economic development	Equal distribution of the generated value	Equity in distribution of generated value (or profit) among the FSC actors (i.e. how much of the profit is generated within each of the FSC stages) calculated as Gini index	%/year	Pending
	Education and knowledge transfer	Number of employees trained	Number of employees trained as % of the total number of employees	%/year	Confirmed
	Education and knowledge transfer	Training and re-qualification of the workforce	Number of people belonging to the workforce trained and/or requalified	%/year	Confirmed
Environmental 		GHGs emissions	CO_2 emissions	g CO_2	Confirmed
		Water availability	Operations are located in a region with medium, high or extremely water stress	High/medium/low risk	Confirmed
		Water management	Implementation of water management plan. The water	Yes/No	Confirmed

			management plan (both for rain-fed and irrigated crops) shall contain good water management practices to optimise water use		
		Water saving	Implementation of water saving practices	Yes/No	Confirmed
		Water depletion	Operations affect the depletion of surface or groundwater resources below replenishment capacities	Yes/No	Confirmed
		Water quality	Wastewater or runoff that contains potential organic and mineral contaminants shall be treated or recycled to prevent any negative impact on humans, wildlife, and natural compartments (water, soil)	Organic matter content measure (>1%)	Confirmed
		Deforestation risk	Risk of forest decrease in the area where crop is located	Yes/No	Confirmed
		Soil quality	Measures to improve soil health are put into place: direct seeding, maintenance of soil cover, crop rotation	Yes/No	Confirmed

		Soil Conservation	Increase of soil organic matter content due to soil management practises	Yes/No	Confirmed
		Biodiversity conservation	Ecological corridors are protected, restored or created to minimize habitat fragmentation	Yes/No	Confirmed
Integrated 	Efficiency	Cascading options	Describes the possibility of subsequent use of an accruing non-product material for material and/or energy i.e. cascade use	Y/N	Pending
	Efficiency	Production efficiency	Describes how efficient biomass is used within the process and thus production is. Determines the amount and use of original feedstock in the target product and how much is lost as unused biomass outside of the product.	%	Pending
	Circularity	Systematic circular incentives	Describes the likeliness to develop circular systems based on incentives e.g. holistic framework, policies, sustainable demands in circularity, (value-creation, risk reduction)	% financial incentive	Pending

	Circularity	Quality degree reduction	Describes the degree of reuse possibility of the product based on the degree of reduction in the quality characteristic. The composition of the product determines if a subsequent use of the product is possible (e.g. containing harmful substances and composites, recycling possibility)	%	Pending
	Technology	Innovation Potential	Describes the distance of an innovation compared to previous solutions. Relative value to describe the state of understanding at the time.	Degree of novelty	Pending
	Readiness level	Technologie Readiness level	This indicator measures the technological development of a specific technology.	TRL unit	Pending
	Readiness level	Market Readiness level	This indicator is about the commodification of a technology, and it addresses how well-developed is the process of adapting the product to the market.	MRL unit	Pending

	Value creation	Regional added value	The amount of value (quality & quantity) created and added to the regional level compared to the status quo. The regional value added increases with the amount of actors involved in the value chain and thus the full utilization of existing regional concepts.	n	Pending
	Flexibility	Flexibility of the design	Adaptability and versatility of the plant design system to be used across systems. Based on integration, acceptance of changing feedstocks, scaling, modification and adjustments of the design	n	Pending
	Benefits	Co-benefits	Additional co-benefits, e.g. enhance knowledge, diversification, added value (valorisation), waste reduction, spillovers from other process chains	n	Pending

References

Angevin, F., Fortino, G., Bockstaller, C., Pelzer, E., Mess´ean, A., 2017. Assessing the sustainability of crop production systems: toward a common framework? Crop Prot. 97, 18–27. https://doi.org/10.1016/j.cropro.2016.11.018.

Bohanec, M., 2015. DEXi: Program for Multi-Attribute Decision Making. User's Manual. Version 5.00.

Declercq, Rémi; Loubier, Sébastien; Condom, Nicolas; Molle, Bruno (2020): Socio-Economic Interest of Treated Wastewater Reuse in Agricultural Irrigation and Indirect Potable Water Reuse: Clermont-Ferrand and Cannes Case Studies' Cost–Benefit Analysis. In Irrigation and Drainage 69 (S1), pp. 194–208. DOI: 10.1002/ird.2205.

Doran, G.T. (1981) There's a SMART Way to Write Management's Goals and Objectives. Journal of Management Review, 70, 35-36. - References - Scientific Research Publishing.

European Parliament and Council. (2013). Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006. Official Journal of the European Union, L 347/320.

Garcia, X.; Pargament, D. (2015): Reusing wastewater to cope with water scarcity: Economic, social and environmental considerations for decision-making. In Resources, Conservation and Recycling 101, pp. 154–166. DOI: 10.1016/j.resconrec.2015.05.015.

Martin, A.E., Collins, S.J., Crowe, S., Girard, J., Naujokaitis-Lewis, I., Smith, A.C., Lindsay, K., Mitchell, S., Fahrig, L., 2020. Effects of farmland heterogeneity on biodiversity are similar to—or even larger than—the effects of farming practices. Agric. Ecosyst. Environ. 288, 106698. https://doi.org/10.1016/j.agee.2019.106698.

Molinos-Senante, María; Hernández-Sancho, Francesc; Sala-Garrido, Ramón (2010): Economic feasibility study for wastewater treatment: a cost-benefit analysis. In The Science of the total environment 408 (20), pp. 4396–4402. DOI: 10.1016/j.scitotenv.2010.07.014.

Palomo-Campesino, S., Gonz´alez, J.A., García-Llorente, M., 2018. Exploring the connections between agroecological practices and ecosystem services: a systematic literature review. Sustainability 10. https://doi.org/10.3390/su10124339.

Pelzer, E., Fortino, G., Bockstaller, C., Angevin, F., Lamine, C., Moonen, C., Vasileiadis, V., Gu´erin, D., Guichard, L., Reau, R., Mess´ean, A., 2012. Assessing innovative cropping systems with DEXiPM, a qualitative multi-criteria assessment tool derived from DEXi. Ecol. Indic. 18, 171–182. https://doi.org/10.1016/j. ecolind.2011.11.019.

Quiroga Martínez, Rayén (2009): Guía metodológica para desarrollar indicadores ambientales y de desarrollo sostenible en países de América Latina y el Caribe. Santiago de Chile: Naciones Unidas CEPAL (Publicación de las Naciones Unidas, 61).

Rösch, Christine; Bräutigam, Klaus-Rainer; Kopfmüller, Jürgen; Stelzer, Volker; Lichtner, Patrick; Fricke, Annika (2018): Indicator-based sustainability assessment of the German Energy System and its transition. Karlsruhe: KIT Scientific Publishing. Available online at https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000082161/.

Sadok, W., Angevin, F., Bergez, J.-E., Bockstaller, C., Colomb, B., Guichard, L., Reau, R., Dor´e, T., 2008. Review article Ex ante assessment of the sustainability of alternative cropping systems: implications for using multi-criteria decision-aid methods. A review. Agron. Sustain. Dev. 28, 163–174. https://doi.org/10.1051/agro.

Timans, Rob; Wouters, Paul; Heilbron, Johan (2019): Mixed methods research: what it is and what it could be. In Theor Soc 48 (2), pp. 193–216. DOI: 10.1007/s11186-019-09345-5.

UNEP (2020): Guidelines for social life cycle assessment of products and organizations 2020. With assistance of Benoît Norris, C., Traverso, M., Neugebauer, S., Ekener, E. Available online at https://www.diva-portal.org/smash/get/diva2:1647964/fulltext01.pdf.