D5.3

Social innovation solutions at local level

DBFZ

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ABBREVIATIONS

AGB	Above ground biomass
AOC	Appellation d'Origine Contrôlée / Controlled designation of origin
BGB	Below ground biomass
CAP	Common Agricultural Policy
CLMIs	Common Land Management Initiatives
Ec	Economic
En	Environmental
EU	European Union
ETS	Emission Trading System
Fit for 55	Package of reformed and new directives and regulations on the European Union's climate policy

GI	Geographic Indication
I	Infrastructural
iLUC	Indirect land Use Change
IP	Indication de Provenance / Indication of Origin
L	Legal
PESTEL+I	Political, Economic, Social, Technical, Environmental, Legal + Infrastructural
P	Political
S	Social
SOC	Soil organic carbon
SWOT	Strength, Weakness, Opportunity, Threat
TOWS	Reverse SWOT
TRL	Technology Readiness Level
T	Technical
WHC	Water Holding Capacity

1. Executive Summary

The goal of CARINA Task 5.3 is to ‘Co-define challenges and co-define social innovation solutions’. As a first step, relevant information was collected from stakeholders on the introduction of the new crops *Brassica carinata* and *Camelina sativa* and related cropping systems in different regions across European (Italy, Spain, France, Serbia, Poland) and North African countries (Tunisia, Morocco). The information was coded into PESTEL and SWOT categories to develop strategies for social innovation solutions and to support sustainable deployment and sustained uptake of the new crops.

Initially, relevant stakeholder groups were predefined. Subsequently, project partners collaborated by filling out stakeholder fact sheets (Figure 1), which outline the role and motivation of stakeholders in potential value chains in their respective countries. From these fact sheets stakeholders were identified and gathered in a comprehensive stakeholder list. Selected stakeholders were then interviewed based on a questionnaire provided by DBFZ (Figure 2).

The compiled results of the survey shed light on a spectrum of quite diverse expectations affecting benefits and challenges/barriers to the introduction of Carinata and Camelina. It often highlighted also the lack of knowledge by stakeholders of the two crops, which can lead to incorrect and incomplete understandings that should be addressed and mitigated. Furthermore, the analysis showed that economic conditions and end-consumer perspectives can considerably vary by region. Therefore, potential value chains and products must be adapted to regional, social, economic, and environmental conditions and must enable sustainable market transfer and increase social acceptance.

The implementation of social innovation solutions alongside the new CARINA crops can enhance its market transferability and acceptance. Among the potential models, cooperatives seem to be the most suitable social innovation to transfer benefits across a wider community of farmers and associated stakeholders. Cooperatives could assist in the dissemination of best practices in crop management, like training for the correct cropping system application, processing, and product marketing for many farmers. This approach can generate positive impacts for agricultural stakeholder, and the surrounding economy and population.

1.1 Current Challenges

Stakeholders and experts identified several challenges in the survey’s answers to the implementation of Carinata and Camelina cropping systems and their associated potential value chains. In general, the majority of farmers is not familiar with either of the two crops. Hence, awareness of benefits of Carinata and Camelina in the farming community is still not well developed. Demonstration cropping trials are ongoing but final research results are not yet available for any of the European and North African countries involved.

While the regulatory framework supports some business models related to CARINA crops — such as their cultivation on marginal lands - the cultivation in rotation with main food crops and following

use[1] in fuel, feed, and food markets — the broader farming community remains largely unaware of relevant instruments, of the legal framework (CAP, RED[2], ReFuelEU aviation[3]), and of existing and possible incentives[4]. Moreover, although some EU-level guidelines exist, their implementation at the national and local levels is often incomplete.

Farmers and agricultural companies are generally cautious about investing unless they have the security of solid markets and established customers client base. Diversification of the product portfolio could be a solution, but several processes and end-products have not yet reached a high enough Technology Readiness Level (TRL) needed for market access.

1.1.1 Social Innovations

Innovation is no longer viewed solely in terms of economic or technological competitiveness and productivity, but increasingly as a driver of social well-being, participation, and sustainable development. 'Social innovation' takes notice of society as a context influencing the development, diffusion/dissemination, and use of innovations[5, 6]. It also highlights that innovations entail not only opportunities, but also potential risks for society[7].

The prerequisite for social innovation is open-mindedness in a broad process that engages politics, public administration, companies, and scientific institutions, as well as the willingness and ability of civil society to cooperate.

Social innovations in the context of agriculture and rural development manifests in different forms and expressions. A well-known example is community agriculture, where crop cultivation, harvesting, processing, and marketing are implemented by cooperatives, small farming communities, or by direct participation of consumers. Another example is joint farmland management, in which larger cooperatives or groups of farms collaborate to optimize resource use and land productivity.

A Social Innovation is defined as '…the social mechanisms of innovation' and 'the social responsibility of innovation', meaning that innovation is based on social processes, and its outcomes should not be harmful to society.'[8]

The following examples illustrate various social innovation initiatives relevant to rural development, agriculture, and community-based enterprise:

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1 https://eu-cap-network.ec.europa.eu/publications/eip-agri-factsheet-sustainable-industrial-crops-europe_de

2 https://eur-lex.europa.eu/EN/legal-content/glossary/common-agricultural-policy-cap.html

3 https://transport.ec.europa.eu/transport-modes/air/environment/refueleu-aviation_en

4 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413&qid=1699364355105

5 Edquist, C. (2001): The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. Lead paper presented at the DRUID Conference, Aalborg, 12-15 June 2001.

6 Fløysand, A. and Jakobsen, S.E. (2011): The complexity of innovation: a relational turn. Progress in Human Geography 35 (3), 328-344. http://dx.doi.org/10.1177/0309132510376257

7 Pol, E. and Ville, S. (2009): Social innovation: buzz word or enduring term? The Journal of Socio-Economics 38, 878-885. http://dx.doi.org/10.1016/j.socec.2009.02.011

8 Bock, B. B. (2012). Social innovation and sustainability; how to disentangle the buzzword and its application in the field of agriculture and rural development. Studies in Agricultural Economics, 114, 57-63. https://doi.org/10.7896/j.1209

Social innovation in land management[1] proposes innovative mechanisms based on different land grouping and management formulas, known as Common Land Management Initiatives (CLMIs). These are designed to **address land abandonment and the lack of competitiveness of associative enterprises in smallholder areas of citrus fruits, stone fruits, nuts, vineyards and olive groves**. Very similar to this example the CARINA project aims to ensure the long-term viability of associative entities and enhance the profitability of their members' production.

Community based development of tourist trails[2] facilitated through a smartphone application **connects a network of people with different and complementary skills and resources.** The initiative supports local collaboration and enables participation of local businesses on sustainable tourism development.

Community garden[3] **produce high quality organic food and vegetables**. They are **community based**, owned and cultivated by the community.

Solidarity farming or community supported agriculture[4] involves **consumers cooperating directly with one or more partner farmers at the local level**. Consumers give a purchase guarantee for products and may participate in farming operation and in production.

Eta Beta[5] is a **social cooperative oriented towards people with social vulnerabilities and marginalization. It provides** involvement in a variety of activities such as **horticulture, food transformation and cooking, artistic pottery, and woodworking**, among others. In addition to workshops and traineeships, the cooperative facilitates long-term job creation.

Salus space[6] is a project experimenting **a new form of living in a multifunctional space open to everyone**, in which social inclusion for migrants and refugees is combined with intercultural welfare and active citizenship, generating resources for self-maintenance and development without relying on traditional assistance models.

Prison honey[7] involves **beekeeping and honey production in a peri-urban "day prison", engaging several prisoners** in productive activities, fostering skill development and social inclusion.

CUIB restaurant[8] is a **zero-waste restaurant and km0 food shop**, integrating sustainable gastronomy with community involvement, with the establishment having a small garden for horticultural production.

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1 https://goinnoland.wordpress.com/

2 https://balatonfelvidekitura.hu/

3 https://www.bioszentandras.hu/

4 http://www.foodmetres-kp.eu/page.DE06.php

5 https://www.etabeta.coop/

6 https://saluspace.eu/

7 https://urbanicebelar.si/en

8 https://incuib.ro/

Agricoltura Capodarco[1] **is a social cooperative** situated in the outskirts of Rome that **employs people with disabilities and socially excluded people. 'Connecting people' is their main philosophy.** The multifunctional cooperative **runs two organic farms and two restaurants, produces wine and other products and runs educational programmes** and much more.

2. Introduction to CARINA

CARINA is a cross-national 4-year long Innovation Action (01/11/2022- 31/10/2026), supported by the European Union (EU) within the framework of the Horizon Europe programme.

The project focuses on new sustainable and diversified farming systems including two oilseed crops: *Brassica carinata* and *Camelina sativa*, able to provide low iLUC feedstocks for the bio-based economy. CARINA aims to demonstrate that increasing the diversification of cropping systems and adopting a well-thought and effective crop combination will enhance both yield stability, farmers' revenue, and the overall sustainability of farming systems. Moreover, CARINA supports the EU strategic goal to providing for the development of a sustainable bioeconomy sector.

To facilitate the safe deployment of innovative systems, CARINA is also addressing certification issues of low iLUC feedstocks intended for the bio-based industry. Nine Lighthouses, 5 Living Labs, and 9 Policy Innovation Labs will be established across Europe taking a lead role in the co-creation of CARINA innovation actions.

CARINA capitalizes on a highly experienced team of 19 partners, +5 affiliated entities, from 13 EU and Associated Countries (Italy, France, Spain, Germany, Greece, Slovakia, Bulgaria, Poland, UK, Serbia, Tunisia, Morocco, Switzerland).

Coordinator: ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA

PARTNERS	SHORT NAME
ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA	UNIBO
ARVALIS INSTITUT DU VEGETAL	ARVALIS
AGRAREN UNIVERSITET - PLOVDIV	AUP
CAMELINA COMPANY ESPANA SL	CCE
CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING FONDATION	CRES
DBFZ DEUTSCHES BIOMASSEFORSCHUNGSZENTRUM GEMEINNUTZIGE GMBH	DBFZ
FLANAT RESEARCH ITALIA SRL	FLANAT
INTERNATIONAL CENTRE FOR AGRICULTURAL RESEARCH IN THE DRY AREAS	ICARDA

1 https://eu-cap-network.ec.europa.eu/sites/default/files/publications/2023-12/eu-cap-network-press-article-social-farming.pdf

INSTITUT ZA RATARSTVO I POVRTARSTVO INSTITUT OD NACIONALNOG ZNACAJA ZA REPUBLIKU SRBIJU	IFVNCS
INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE DE TUNISIE	INRAT
NOVAMONT SPA	NVMT
PEDAL CONSULTING SRO	PEDAL
UNIWERSYTET PRZYRODNICZY W POZNANIU	PULS
SAIPOL	SAIPOL
COOPERATIVAS AGRO-ALIMENTARIAS DE ESPANA U DE COOP SOCIEDAD COOPERATIVA	SPANISH CO-OPS
COOPERATIVAS AGRO-ALIMENTARIAS DE ANDALUCIA	FAECA
FEDERACIÓN ARAGONESA DE COOPERATIVAS AGRARIAS	FACA
UNION REGIONAL DE COOPERATIVAS AGRARIAS DE CASTILLA Y LEON	URCACYL
COOPERATIVAS AGROALIMENTARIAS CASTILLA LA MANCHA UNION DE COOPERATIVAS	CACLM
FEDERACIO DE COOPERATIVES AGRARIES DE CATALUNYA	FCAC
TERRES INOVIA	TI
KIMITEC BIOGROUP SL	KIMITEC
RSB ROUNDTABLE ON SUSTAINABLE BIOMATERIALS ASSOCIATION	RSB
NUSEED EUROPE LTD	NUSEED

3. Methodology

In a first step, existing literature was reviewed and research conducted on the current European context of social innovation, both in general and in its application for rural development and related fields.

To gather stakeholder information, template fact sheets (Figure 1) were distributed to project partners. The completed stakeholder fact sheets contained information such as the stakeholder group, motivation, and role for each participating country (Tables 1-12). Stakeholders were identified for each of the following groups: 1. Upstream/feedstock providers, 2. Producers, 3. Service providers, 4. Downstream customers, 4. Politics, 5. Society/Research.

Stakeholder group description (Upstream/feedstock providers; Producers; Service providers; Downstream costumers; Politics; Society/research) **Country/region**:
Motivation to participate in Carina value chain (specify Camelina or Carinata)
Define role in the Carina value chain
Please identify at least two stakeholder of the category

Figure 1: Template for stakeholder fact sheets

The collected information was compiled in a stakeholder list (Table 13), which was expanded through snowball sampling and further desk research. For reasons of confidentiality, the list published in the present report includes only generic and anonymised information.

For implement innovations to be socially accepted solutions, they must involve stakeholder from all sectors of society— policy, economy, business, and civil society— and collect opinions and feedback. Therefore, a selection of stakeholders was selected to be interviewed to collect qualitative information about the CARINA macro-environment.

The selected stakeholders displayed very different levels of knowledge and understanding of the topics under questioning. To categorize the collected data, the PESTEL+I framework was used. A questionnaire template (Figure 2) was developed, with questions formulated to elicit information in the context of CARINA implementation and social innovation. The qualitative data obtained were coded using qualitative data analysis software. Subsequently, a SWOT/TOWS matrix (Table 16) was prepared to derive strategies (6.1-6.4) and conclusions for the development of social innovations, as well as general recommendations to address challenges related to the market transfer of CARINA crops.

1 Can you please describe the agricultural structures in your region (farm sizes, ownership, cultivated crops, cropping periods/cycles, …)?

2 What are the **most relevant challenges** in agricultural practice in your region?
Please,

- **1.1** **specify political or legal constraints** for your activity (policy framework, public funding priorities, restrictions …)?
- **1.2** Do you face **any economic constraints?** (lack of financing, market fluctuations)
- **1.3** Do you see any **social problems in your region** (unemployment, infrastructure, education, …)?
- **1.4** Can you **define one or two technical gaps/challenges** in your process.
- **1.5** Do you see **any specific environmental constraints** for your activity (climate change, drought, …)?
- **1.6** Do you see any specific **potential infrastructural constraints** for your activity (bad roads, structural lack of access to market, storage …)?
- **1.7** Which **other challenges** are you facing?

3 Please define your perception of the following terms:
"social innovation"
"community supported agriculture"
"marginal land"

4 Could you help the community with your activities to solve social problems and challenges?

Figure 2: Stakeholder questionnaire

CARINA expert note: It should be noted that the interviewed stakeholders may not have developed yet the necessarily possess specific expertise in the applicable legislation or in the broader agronomic, environmental, or economic context of the CARINA crops. Their responses are primarily based on their own experiences and perceptions, which may be subjective and influenced by local circumstances. Consequently, the qualitative insights gathered through the questionnaire (Figure 2) provide valuable indications of attitudes, awareness, and perceived challenges, but they should not be interpreted as being fully representative or exhaustive of the situation at national or regional level.

4. Key Stakeholders

The key stakeholders for each of the countries involved in the CARINA project were identified in collaboration with project partners through snowball sampling. The stakeholders, along with their motivations and roles, are described in stakeholder fact sheets (Section 4.1). A generic stakeholder list (Section 4.2) shows the most important actors relevant for the CARINA value chains.

4.1 Stakeholder Fact Sheets

Table 1: Stakeholder fact sheets Spain – Part I

Upstream/feedstock providers	Producers	Service providers
Agrifood cooperatives and their members (farmers): (a) robust & productive cash-cover crop for marginal areas (replacing fallow lands), (b) crop suitable to grow under conditions featuring	Agrifood cooperatives and private companies: (a) oil extraction for the marketing companies, (b) oil cake for the	Private companies: (a) seed provider, (b) technical assessment in the crop management, (c) purchasing manager (they grant the purchase of the harvest to the

semiarid climate, (c) additional income.	animal feedstuff sector, (c) the husk usable as cattle bedding.	farmers through contracts), (d) varieties genetic improvement, (e) oil extraction.
Motivation to participate in Carina value chain		
Additional income (replacing fallow lands by cash-cover crop). Diversify their agricultural production to minimise market related risks. Need to cultivate/upgrade degraded soils. Fight water scarcity. Looking for pest resistant crop because specific pesticides, herbicides are not anymore permitted.	Satisfactory experiences with Camelina oil extraction. Seed performance is similar/better than rapeseed. The Camelina oil by-products have interesting markets for them. Diversify their production portfolio.	Generate additional produce, not to displace existing crops. Opportunity to produce oil for conversion into advanced biofuels. Improve genetic features through data-based process. Regarding the selection carried out so far for the new varieties, this is not aimed at increasing yields in fresh drylands (where there are already alternatives such as rape or sunflower), but rather at developing solutions for areas where there are no alternatives (e.g. dry and semi-arid areas).
Define role in the Carina value chain		
Upstream feedstock provider for biorefinery (oil, biofuels), biobased products manufacturers, food and feed industry.	Extraction of vegetable oils	Integral approach by performing the genetic improvement to adapt the varieties to farmer needs, providing them the seeds, following-up crops development and advising the farmers on their management, purchasing their harvest, extracting the oil and finally selling it to bio-fuels producers.

CARINA Expert note: According to Article 26 of the Renewable Energy Directive (RED III), the use of food and feed crops for production of biofuels must not exceed the 2020 levels, with a cap of 7% in transport energy. Moreover, EU Member States can reduce this share and shift towards Annex IX feedstocks. Any additional displacement of food crops to produce energy would be inconsistent with the RED sustainability criteria and would not count towards renewable energy targets if above the crop cap.

Unlike conventional main crops, which are crops used in the production of first-generation biofuels and thus subject to limitations under Article 26 and 27 of RED III, crops such as Camelina and Carinata qualify as advanced biofuel feedstocks when cultivated as intermediate crops (part of a crop rotation and not increasing land-use), or on severely degraded lands, and are outside of the crop cap. These advanced feedstocks are promoted under Article 29 and Annex IX of RED III, allowing their contribution to the binding advanced biofuels targets set for Member States.

Table 2: Stakeholder fact sheets Spain – Part II

Downstream Customers	Politics	Research/society
Biorefineries and airlines: (a) advanced biofuels production, (b) advanced biofuels consumption	Spanish Agricultural Ministry and Regional Governments: (a) promotion of protein crops, (b) understanding technical barriers, (c) Alternatives for advanced biofuels manufacturing.	Research and technological centres: (a) robust & productive cash-cover crop for marginal areas (replacing fallow lands) and for integration into a crop rotation, double cropping with main food crops (b) genetic improvement addressing specially crop resistant features to semi-arid conditions, (c) additional income for farmers, (d) advanced biofuels production.
Motivation to participate in Carina value chain		
Interest in new sources of feedstock for advanced biofuels (requirements as per EU legislation such as the RED, ETS, and Fitfor55). Interest in decreasing the CO_2 footprint and comply with the new demands of the EU legislation. Certain oil companies claim that they aim to lead biofuels manufacturing in Spain and Portugal by 2030, with an annual production capacity of 2.5 million tonnes, focusing especially on boosting the sustainability of air traffic, reaching an annual production capacity of 800,000 tonnes of Sustainable Aviation Fuel (SAF).	Camelina and carinata are crops eligible for the fund of improvement crops in Spain within the new CAP 2023 (Carbon farming and agro-ecology eco-scheme: crop rotation and sowing-Crop rotation practice with crop improvement species). This is a crop of interest, which would fit in with CAP objectives. Interest in increasing the availability of plant protein in Spain from Camelina. Search of alternatives in this case Camelina varieties- adapted to harsh conditions (arid or semiarid areas). Understand the genetic improvement. Replace fallow lands by cash-cover crops. Support Intermediate cropping between two main crops. Gain knowledge on its suitability for advanced biofuels manufacturing.	Search of alternatives, varieties-adapted to harsh conditions (arid or semiarid areas). Understand the genetic improvement. Replace fallow lands by cash-cover crops. Intermediate crop between two main crops. Since 2012, emission control and balancing standards in the international aviation sector have been tightened. As a result, researchers around the world have embarked on the development of biofuels that function as substitutes for paraffin. Accordingly, efforts are undertaken to promote cultivation of qualifying and efficient crops, which can supply the production of advanced biofuel. Gain knowledge on its suitability for advanced biofuels manufacturing.
Motivation to participate in Carina value chain		
Biorefineries transforming oil into advanced biofuels, e.g., for reducing the carbon footprint of aviation.	Setting the regulation framework that affects the crop.	Provide additional income to farmers and new raw materials to the biofuel industry with. Scaling up from lab techniques to real conditions, provide stakeholders

		with state-of -the-art technologies for better yields on oil extraction and by-products use.

CARINA expert note: RED III is valid for all EU Member States. In addition to cultivating on marginal lands or replacing fallow, RED III supports feedstock production through intermediate/catch crops, the use of its residues and waste, and the cultivation on low biodiversity land under strict ILUC-risk mitigation measures. The common requirement across all pathways is **no displacement of food/feed crops** and adherence to strict sustainability and traceability criteria.

Table 3: Stakeholder fact sheet France

Producers	Downstream customers I	Downstream customers II
Crushing industry	Feed industry	Biofuel industry
Motivation to participate in Carina value chain		
Create business with feed producers Create business with vegetable oil consumers for advanced biofuels (as intermediate crops would be considered as advanced feedstocks) Diversify feedstocks and sourcing Develop local sourcing for national / EU-origin markets	Diversify protein-rich meals for feed formulation Access local / national feedstocks Access sustainable feedstocks	Access vegetable oil that is eligible originating from cover crops Address the advanced biofuels markets, especially the Sustainable Aviation Fuels market
Define role in the Carina value chain		
Transformation of the seeds provided by upstream stakeholders, to produce vegetable oil for food, biofuel and chemistry uses and protein meals for the feed industry	Formulate and produce the compound feed with Camelina and Carinata meal and sell it to farmers	Use Carinata and Camelina oils to produce biodiesel (fatty acid methyl esters and/or hydrotreated vegetable oils)

Table 4: Stakeholder fact sheet Italy – Part I

Upstream/feedstock providers	Producers/Service providers	Downstream costumers
Agricultural cooperative or company looking for: (a) robust & productive cover crop for marginal areas, (b) crop for	Biorefinery looking for feedstock diversification, interested in low cost and low input oilseed crops with high quality features	Buyers or users (chemical industry, food, nutraceutical and feed industry) Biochemicals processing industries

drought prone areas, (c) additional income.	Biobased products' manufacturers working with biopolymers, willing to differentiate their feedstock resources. Technology developer, logistics, finance	
Motivation to participate in Carina value chain		
Looking for pest resistant crop because specific pesticides/herbicides are not anymore permitted, crop diversification, valorisation of marginal land, integrate biobased products value chains, (for Camelina) subsidy transfers from the EU, implementation of cash cover crops to replace fallow and as an intermediate crop between two main crops, address water scarcity by improving crop resilience and reducing water use/improving water availability.	Promotion of sustainable value chains based on regenerative agriculture and renewable resources. Proximity of partners to establish collaborative value chains that can be reshaped more easily to fit transformation needs. Stability of feedstock, less subjected to fluctuations of imported feedstock market.	Integration of Carinata and Camelina in the "seed to shelf" strategy to produce food supplements, cosmetics and veterinary products from botanicals. Proximity of partners to promote collaborative downstream value chains to drive qualitative and quantitative enhancement of botanical active ingredients.
Define role in the Carina value chain		
Upstream feedstock provider for biorefinery (seed), biobased products manufacturers, food and feed industry.	Biorefineries and biobased products manufacturers.	Processing companies working with biobased products.

Table 5: Stakeholder fact sheet Italy – Part II

Politics	Research/society
Regional governments and national agriculture ministry.	Universities and research institutions willing to conduct research on new oilseed crops featured by low iLUC.
Motivation to participate in Carina value chain	
Promotion of diversification in agriculture, part of the bio-district strategy. Definition of supportive policies for innovative cover crops. Public investment in circular and sustainable value chains.	Conduct research on optimal features of Carinata and Camelina cropping systems, both in agronomical and economic terms. Test different cropping options for the cultivation of Carinata and Camelina. Develop different business models for Carinata and Camelina value chains.

Respond to EU policy on the promotion of cover crops.	Evaluate the sustainability of Carinata and Camelina value chain. Assess potential social benefits and impacts on stakeholders and wider society. Integrate research activities in teaching programmes (didactic purposes).
Define role in the Carina value chain	
Policymakers	Research on Carinata and Camelina

Table 6: Stakeholder fact sheet Poland

Upstream/feedstock providers	Producers	Service providers
Farmers, cooperatives	Producers of oils and animal feed.	Agricultural Advisory Centre Agency for Restructuring and Modernization of Agriculture.
Motivation to participate in Carina value chain		
Camelina and Carinata plants have little soil requirements, Camelina and Carinata plants are resistant to weather conditions, introduce biodiversity. Camelina and Carinata plants can be used as catch crops, looking for pest resistant crop.	Camelina oil is a regional product of Poland, companies in Poland that buy seeds and produce oil, straw can be used, cake can be used as a feed ingredient	
Define role in the Carina value chain		
Valuable natural ingredients in Camelina and Carinata plants will expand the possibilities of their use. The Agricultural Development Centre encourages farmers to cultivate and will prepare a promotional campaign.	Oil producers will expand their offer with Camelina oil. Feed producers will expand their offer with vegan feed enriched with raw material rich in unsaturated fatty acids.	

Table 7: Stakeholder fact sheets Serbia – Part I

Upstream/feedstock providers	Producers	Service providers
Farmers, associations of farmers and agroindustry in the area of primary	Food and feed producers, agrochemical industry, biorefineries and other process	Technology innovation centre or a company providing production programs, products and services

production of field crops looking for: (a) robust & productive cover crop for marginal areas, (b) crop for drought prone areas, (c) cash-cover crops and intercropping systems solutions, (d) sustainable farming, (d) additional income.	industries looking for: (a) a stable source of raw material for production needs, (b) value for money products, (c) sustainable production, (d) a place in the new value chain and new market opportunities.	to process industries in agriculture, food and feed, agrochemicals, biorefinery.
Motivation to participate in Carina value chain		
Fight water scarcity Need to cultivate/upgrade degraded soils Practicing sustainable farming (organic and regenerative farming, low input farming) Looking for pest resistant crop or alternative cultivation practices because specific fertilizers, pesticides/herbicides are not permitted anymore Additional income from oil and extension of (bio-based) products portfolio Create business with nearby food/feed producer or biorefinery	Stable supply of raw or processed materials for production streamline Ability to obtain raw materials for affordable prices and from sustainable sources Sustainable production and lower impact on the environment Innovative bio-based products solutions Ability to join the new value chain or to position themselves in the value chains/grids (on the national and European level)	Sustainable production and lower impact on the environment Innovative bio-based products solutions Ability to join the new value chain or to position themselves in the value grids (on national and European level)
Define role in the Carina value chain		
Upstream feedstock providers for bio-based products manufacturers, food and feed industry and biorefinery (oil, biofuels)	Bio-based products manufacturers (food and feed industry, oil, biorefinery, biofuels)	Implementation of research and development projects, service to process industry, networking and market opportunities

Table 8: Stakeholder fact sheets Serbia – Part II

Downstream Customers	Politics	Research/society
Agricultural cooperative or company looking for seed and livestock producers; animal breeders; food/feed producers; food/feed market chains	National, provincial, municipal government bodies from agriculture, environmental (waste, circular economy), economy and industrial sectors	Universities, activists' groups, NGOs, community, media, private individuals

Motivation to participate in Carina value chain		
Continuous supply of raw or processed materials for production streamline Ability to obtain raw materials for affordable prices Sustainable production and lower impact on the environment Innovative bio-based products Ability to join the new value chain or to position themselves in the value chains/grids (on the national and European level) Reduction in dependency on fossil resources	Regulation for new farming systems supporting agrobiodiversity and sustainability Knowledge to support transformation of farming and production systems with a view to align national strategies with European Rural development support	Guidance to new production systems and solutions to agriculture transformation Up-to-date information on agriculture, environmental, economy and industrial sectors Comprehensive analyses of different technologies, fields of research and their costs, new products/processes/materials innovations, flexibility of plants and feedstock, product life cycles, governmental research expenditures, biomass specifications Changes in social thinking, consumer convenience, income distribution
Motivation to participate in Carina value chain		
Buyers or users of bio-based products	Defining pathways to conscious, sustainable farming systems, support to transformation of national agricultural sector; governmental subvention, consumer incentives, taxation regulations, trade barriers	Contributing to advance the field of research and development within the Carina project by sharing experience and knowledge.

Table 9: Stakeholder fact sheets Morocco – Part I

Upstream/feedstock providers	Producers I	Producers II
Farmers/women cooperatives	Farmers/women cooperatives	Edible oil producers
Motivation to participate in Carina value chain		
Camelina: Camelina is suitable for cultivation in marginal soils/land, Camelina as one of the options for deployment in rotations in cereal-based cropping systems, suitable for cultivation in olive orchards, can grow under	Camelina: Need for healthy oil for human consumption and application on skin, value addition to produce shampoo, soaps and other health care products to sell along with Argan (*Argania spinosa*) oil and its value-added products, opportunity to produce value-added products by mixing	Camelina: Currently, soybean, coconut and palm for oil are imported, not grown in Morocco; Camelina is adapted to Morocco and hence its production in Morocco will reduce the dependency on imports. Local production reduces input costs and hence increases profitability. Value addition through producing

low input and drought conditions. Carinata: Options for deployment in rotations in cereal-based cropping systems	Camelina and argan oil, to harness double benefits on skin care. Carinata: produce soaps and other oil-based products, to produce biofuel in long term perspective	healthcare products increase stable income for the company. Currently Morocco depends mainly on imported oil cakes for animal feed production. Camelina cake can substitute this import and reduce import dependency. Cheaper locally produced oil and cakes stimulates local industries. Carinata: Locally produced Carinata oil reduces import dependency for production of soap and other products. Biofuel is not yet popular in Morocco. Carinata production stimulates production of biofuel in Morocco by biorefineries.
Define role in the Carina value chain		
Upstream feedstock provider for biorefinery (oil producer), biobased products manufacturers, food and feed industry.	Oil producer and bio-based products manufacturer, including food and feed	Producing Camelina oil, cakes and bio-based products for food and feed Producing Carinata oil and cakes for biofuel and feed, respectively.

Table 10: Stakeholder fact sheets Morocco – Part II

Downstream customers	Politics	Research/society
Buyers or users (chemical industry, food and feed industry)	National government, federal state, municipal level authority	Technology developer, community, media, private individuals, NGOs, activist groups, universities
Motivation to participate in Carina value chain		
Camelina: Camelina seeds have 30-40% oil which is edible, Camelina cake is good animal feed with 35-40 percent protein, 6-12 percent oil, 6-7 percent ash and 41 percent neutral detergent fibre, low glucosinolate lines for cultivation are available, health benefits: The oil has a desirable 2:1 ratio of omega-3 to omega-6 fatty acids and	Camelina: Morocco imports 90-95% of its oil and cake requirements from South America and Ukraine and consumes lots of its foreign exchange reserve. Therefore, Camelina can be an alternative oil seed crop for Morocco, since it can be grown well in marginal soils, could reduce import dependency and save foreign exchange reserve. Recent Ukraine and Russia war,	Camelina: Results from 4CEMED shows that Camelina can be adapted to marginal lands and tolerate drought and yield some grains, in Morocco and the North Africa, even during severe drought years, while cereals produce very low or zero yield. Exploit health and economic benefits. Carinata:

rich in Vitamin E; abundant in sterols in the oil helps to control cholesterol; the oil is a good skin moisturizer, improve skin tone and prevent free radical damage, good for the brain, eyes, nerves, arthritis and prevents aging, Camelina oil gives a high smoke point of 246°C and good for frying and cooking Carinata: Producing biofuel	disrupted supply chain of sunflower oil from Ukraine, resulted in short term deficient in supply in Morocco. The results of 4CEMED and CARINA shows that Camelina can be fitted well in rotations in cereal-based cropping systems in Morocco. Supporting Camelina cultivation in Morocco by National Government through policies by providing incentives (such as subsidies for fertilizer, seeds; or providing support price, etc.) or supporting in establishing oil extracting factories at initial stages or supporting value addition through farmers/women cooperatives, will stimulate farmers to grow Camelina. Carinata: Government policies to promote biofuel, create demand for Carinata and thereby promoting Carinata cultivation.	Research and Development on Carinata in America for its cultivation and for biofuel production motivated to popularize Carinata in Morocco as a biofuel/energy crop.
Define role in the Carina value chain		
Value addition to Camelina oil and cakes through partnership with farmers/women cooperatives	Promoting government policies for Camelina cultivation and value additions Promoting biofuel policies which promotes Carinata and Camelina cultivation	Co-designing locally adaptable technology for Camelina and Carinata production in Morocco. Popularization of Camelina and Carinata among the stakeholders including farmers. Promote dissemination of information on Camelina cultivation, value addition and health benefits.

CARINA expert note: Camelina oil is primarily used for biofuel production, especially in the U.S., Argentina, and some countries of Europe, where value chains are already established and regulations are being implemented or adapted to support its use in renewable fuels, particularly in aviation transport. In Morocco, however, no such value chain currently exists. As a result, local stakeholders may not yet have a full understanding of Camelina's potential end uses.

Table 11: Stakeholder fact sheets Tunisia – Part I

Upstream/feedstock providers	Producers	Service providers
Association of farmers interested to: (a) productive	Company looking for: (a) Productive oil seed crops, (b) oil	Pesticides, seeds and fertilizer provider looking for: (a) any new

cover crop for marginal areas, (b) crop tolerant to drought, (c) sustainable agriculture, (d) animal feed, (e) additional income	production, (c) cake production, (d) additional income	crop, (b) crop diversification, (c) more benefits for farmer and the company, (d) dissemination of research results
Motivation to participate in Carina value chain		
Diversification of crop rotation, additional income from oil and extension of bioproducts, need to cultivate/upgrade degraded soils, fight water scarcity	Additional crops producing oil and cake, additional income from oil and bioproducts, create business with nearby biorefinery or food/feed producer	Looking for new crop, additional income from specific pesticides for the new crops, create new business with selling seeds of the new crops
Define role in the Carina value chain		
Provider of seeds for biobased products manufacturers, for food and feed industry	Produce oil for biorefinery and oil/cake for biobased products for feed industry	Provider of seeds and inputs

Table 12: Stakeholder fact sheets Tunisia – Part II

Downstream customer	**Politics**
Company looking for: (a) Productive oil seed crops, (b) oil and cake production, (c) additional income.	Ministry of Agriculture water resources and fisheries looking for: (a) crop diversification, (b) Productive cover crop for marginal areas, (c) crop tolerant to drought (d) additional income of the country's economy.
Motivation to participate in Carina value chain	
Additional crops producing oil and cake, additional income from oil and bioproducts, create business with nearby biorefinery or food/feed producer	Looking for low input crops, additional income from oil and extension of bioproduct for farmers, need to cultivate/upgrade degraded soils, fight water scarcity
Define role in the Carina value chain	
Company producing oil seeds for biorefinery (oil), and biobased products for feed industry	Contribution to the preparation of programs and development plans relating to agricultural production, in particular strategic sectors. Implementation of actions to improve agricultural production and their qualities (signs of quality linked to origin: AOC, IP) and acts as chairman and secretary of the technical advisory committee for GIs (AOC and IP)

4.2 Stakeholder list

Table 13: Stakeholder list CARINA

Stakeholder group	Generic description
Upstream/feedstock provider	1 Farmer 2 Farmer cooperatives 3 Agricultural service 4 Women cooperatives 5 Agrifood cooperatives
Producer	6 Organic food producers (e.g., edible oil-, protein) 7 Feed producers 8 Flour producers 9 Seed producers
Service provider	10 Crushing producer/Crusher 11 Food and feed process industry and analytical service 12 Machinery and logistics providers 13 Organic products traders national and international 14 Insurance companies 15 Commercial banks
Downstream customer	16 Biodiesel producer and (bio)fuel companies 17 Feed companies 18 Biorefinery 19 Agrochemical industry, 20 Plant protection producers 21 Supermarket chains 22 Airlines
Politics	23 European commission 24 National government 25 Regional government 26 Agriculture ministry and departments 27 Ministries of Environment and Water 28 Agricultural policies in the field of rural development and European integration

Research/society	29 Technology developer 30 Research institutes engaged in organic farming, biodiversity and crop cycles 31 Biomass research institutes 32 Biofuels research institutes 33 Water management institutes 34 Energy research institutes 35 Consultancy engaged in trainings related to food safety 36 Plant breeding and genetics 37 Communities and municipalities 38 NGOs engaged in education of farmers 39 National associations for business and commerce 40 Association of organic farmers

5. PESTEL – Enablers and Challenges

To collect and categorize relevant information collected from literature, experts and end users the PESTEL+I methodology was used[1]. The analysis considered political, economic, social, technical, environmental, legal and infrastructural aspects. Data were collected through semi-structured expert interviews, interviews with end users as well as through desk research and stakeholder workshop discussions (total: 37 interviews; Spain 11, Serbia: 12, France: 3, Italy: 3, Morocco: 8).

To ensure intercoder reliability and minimize individual researcher bias, several researchers coded the data independently using a Computer Assisted Qualitative Data Analysis Software, applying the PESTEL+I framework as coding structure. The preliminary PESTEL+I analysis was discussed again in stakeholder workshops and round table meetings to collect further input and comments. Finally, enablers and challenges relevant for the CARINA crops implementation and the development of social innovation solutions were assigned to each of the PESTEL+I categories, as well as to a corresponding SWOT/TOWS matrix. These data formed the basis for the formulation of social innovation solutions. The mentioned factors represent end user perspectives and expert statements collected during the semi-structured interviews, interviewed stakeholders (anonymous) are reported in square brackets.

Table 14: Enablers

PESTEL+I categories	Enablers

1 Blümel, L., Siegfried, K., Riedel, F. et al. Are strategy developers well equipped when designing sustainable supply chains for a circular bio-economy? Supporting innovations' market uptake in a PESTEL + I environment. Energ Sustain Soc 13, 40 (2023). https://doi.org/10.1186/s13705-023-00415-2

Political (P)	E1: Intermediate crop status (listed in RED III annex IX). [Researcher at oilseed processing company, France] E2: Generate new possibilities for crop rotation and diversification under the new CAP regulatory framework (Ec, En) [Farmer cooperative, Spain] E3: Providing alternatives to fossil fuels, producing carbon negative crops, decreasing the carbon footprint and improving arable soils. (Te, En) [Agricultural engineer, Spain], E4: Growing Camelina and Carinata on severely degraded lands can enable deployment in comparably large biofuels market incentivised by RED, annex IX (Ec) [Researcher at oilseed processing company, France]
Economical (Ec)	E5: Camelina provides an income that adds to the total economic balance [Researcher at oilseed processing company, France] E6: Camelina could provide products for different markets (biofuel, feed, supplements, food (edible oil rich in Omega 3 fatty acids) [Italian company] E7: Value chains can be structured in cascades (first production of biofuels, residues (cakes) can be used to produce feed, supplements, bioherbicides etc.) (Te, En) [Researcher at oilseed processing company, France] E8: Double market: 1. Protein meal: currently feed industry. 2. Vegetable oil: ready to pay market = biofuels -> sustainable feedstocks, residues cannot be sufficient to cover demands for SAF [Researcher at oilseed processing company, France] E9: Incremental value adding crop improves self-sufficiency of farmers (for feed production) [French farmer] E10: Camelina cake can be marketed as a vegetable raw material for feed producers for fattening animals (Te) [Farmer cooperative, Spain] E11: Trials in energy cultivation are of great interest, feedstock for bioenergy (P) [Agricultural company, Italy] E12: Soil quality improvement and ecosystem service as an incentive to grow Camelina/Carinata, incentives of the CAP regulatory framework (P) [Network of producers, France]
Social (S)	E13: Camelina and Carinata are grown in rainfed conditions, they can have an impact in areas where there is a need to hold the population. Cultivation options are increased, new business models offered. (Ec) [Researcher at technology centre, Spain] E14: Camelina might be easily integrated in land restoration strategies (Te, En) [Researcher, desk research/workshop discussion] E15: Social education in terms of reuse and revaluation of certain by-products of new crops [Agricultural engineer, oil processing company, Italy]
Technological (Te)	E16: Camelina (and Carinata) are highly resilient and adaptable oilseed crops with production capacity in areas with minimal rainfall, medium agricultural input requirements and they have high potential of greenhouse gas emission reductions (En) [Farmer cooperative, Spain] E17: Carinata and Camelina work very well as secondary crops, as they are soil improvers, take advantage of leaching and leave nutrients on the soil surface for the next crop [Agricultural engineer, oil processing company, Italy] E18: Development of ingredients for supplements [Italian company] E19: Successful in marginal areas [Researcher at University, Faculty of Agriculture, Serbia] E20: Carinata and Camelina offer solutions to current agricultural challenges. (En) [Researcher, desk research/workshop discussion] E21: Camelina increases chances of crop success under drought conditions (En) [Researcher, desk research/workshop discussion]

	E22: Camelina: increase options of crops/crop rotations in cereal-based cropping system [Moroccan farmer] E23: Camelina supports growth (attracts) of useful insects (hoverflies) as natural pest control (they breed in larvae of the rapeseed beetle) (En) [Researcher, Camelina expert, Germany]
Environmental (En)	E24: GHG emission saving potential as benefit for the society (En) [Oilseed processing company, France] E25: Camelina and Carinata could be cultivated in marginal lands (P, Ec) [Researcher, desk research/workshop discussion] E26: Techniques such as cover crops significantly improve soil quality[1] (increase of SOC[2]) [Researcher, desk research/workshop discussion] E27: Cultivation of some conventional crops not recommended anymore due to lack of water or rain. Camelina can serve as an alternative for deployment in rotation. (Te) [Moroccan farmer]
Legal (L)	(see Political)
Infrastructural (I)	E28: Oilseeds producers already have the necessary equipment and infrastructure for operation and production. [Researcher at oilseed processing company, France]

Table 15: Challenges

PESTEL+I categories*	Challenges
Political (P)	CH1: Absence of consistent agricultural policy and support measures. Frequent change of policy guidelines. [Chamber of Commerce and Industry, Serbia] CH2: Unregulated market, volatile market prices (Ec) [Moroccan farmer] CH3: For farmers burdensome aspects of the CAP (e.g. restriction for herbicide application) [Farmer cooperative, Spain] CH4: No policy to provide financial assistance to farmers during drought seasons (Ec, En) [Moroccan farmer] CH5: Subsidies/tax rebate/agricultural credits provided by the government on the inputs such as fertilizer and seeds may not be sufficient (Ec) [Moroccan farmer] CH6: Missing government support for cooperatives [Moroccan farmer]
Economic (Ec)	CH7: Constraint is the lack of market, *Brassica carinata* is not a food crop and *Camelina sativa* is sometimes considered [because not well informed] as an alternative (competitor) to other crops that are well established in the current market (such as rapeseed). [Researcher at technology centre, Spain] CH8: Lack of money for investments [Moroccan farmer] CH9: Rising production costs (e.g. personnel, fertiliser) and inflation [Spanish farmer] CH10: Difficult market situation (selling prices for products too low), no or low profits [Spanish farmer]

1 https://doi.org/10.15244/pjoes/147187

2 https://doi.org/10.1016/j.agee.2025.109563

	CH11: Market introduction of low revenue product difficult. Final economic balance must be profitable. [Spanish farmer] CH12: Hard to approach the agri-food world. Big companies are asking for massive quantities (of Camelina) for test trials (Te) [Italian company] CH13: There are already market outlets for what is considered as by-product for animal feed (cake), but the oil has virtually no market, because cheaper options are available. [Italian company] CH14: [Extreme] Drought related crop failures cause financial damage (En) [Spanish farmer] CH15: Cost of cultivation is increasing. Market price of the products is volatile and most of the time not in a profitable range [Moroccan farmer]
Social (S)	CH16: For some territories Camelina is not a typical culture. [Italian company] CH17: Mind changes among farmers needed, lack of knowledge. [Agricultural engineer, Spain] CH18: Workforce is missing, more families stop farming because generational problem. [Oil processing company, Serbia] CH19: The wider political framework that would sustain Camelina cropping has been confronted by farmers. (P, Ec) [Italian farmer]
Technological (Te)	CH20: Risk of lower yields regarding following crops (e.g. sunflowers after Camelina). Integration into existing farming systems might bring negative impacts, e.g. on food crops. [Network of producers, France] CH21: Cooperative/storage agencies are not all equipped and trained to manage Camelina and Carinata. (I) [Researcher at oil seed processing company, France] CH22: On marginal land (severely degraded lands with unproductive soils) loss of unit profitability per unit of surface area (relatively low yields) resulting in lower profitability in the end in such areas. [Agronomic and food researcher, Spain] CH23: During severe drought Camelina may not compete in terms of production and profitability. (Ec) [Agronomic and food researcher, Spain] CH24: Problems (Carinata) occurring with lepidopteran feed on the flowers. [Researcher at technology centre, Spain]
Environmental (En)	CH25: Climatic conditions have taken on extreme characteristics which may be even detrimental for Carinata and Camelina cultivation. [Farmer and researcher, Serbia]
Legal (L)	CH26: Key pesticides are banned. [Moroccan farmer] CH27: Only few herbicides for Camelina cultivation available and on protected marginal lands no herbicides permitted. [Public research, Spain] CH28: Lack of viable and cost-effective alternatives to current plant protection products. (Te, Ec) [Spanish farmer] CH29: High level of administration at every step, even after the introduction of e-agri (an electronic application for producers), complicates work in agriculture, especially when it comes to international traffic. [Researcher at University, Faculty of Agriculture, Serbia] CH30: For Carinata, there are impediments to achieving the chemical characteristics of other crops. Carinata contains high levels of glucosinolates, which limit grain cake use for forage. Carinata contains high levels of erucic acid, which can cause heart problems (fatty acid limited by the EU to 3%). (Te) [Researcher at technology centre, Spain]
Infrastructural (I)	CH31: Lack of infrastructure for supplemental irrigation to overcome effect of recurrent droughts. (En) [Moroccan farmer] CH32: Lack of storage infrastructure. [Moroccan farmer]

CARINA expert note: some interview statements of stakeholders (e.g., CH7-10 in the economic category, CH26-28 in the legal category) may reflect the economic and legal situation in 2023 when most of the interviews were conducted. Production and processing costs, product and market prices as well as the legal framework may have changed since then which is not shown in the PESTEL+I analysis.

6. SWOT/TOWS: Strategies and Lessons Learned

To develop recommendations and strategies for Carinata and Camelina with respect to market transfer and social innovation, the information collected through the PESTEL+I analysis was further categorized into challenges (CH), and enablers (E) (Tables 13-14). These factors were subsequently organized into the SWOT framework — distinguishing them into internal strengths, internal weaknesses, external opportunities and external threats (Table 15). Building on this, the enabling and hindering factors identified through the SWOT analysis were combined using the TOWS approach to develop strategies (3.1 – 3.4) which could help overcome current challenges for implementation of the new oil crops and provide solutions for social innovation.

Table 16: SWOT as per country specific stakeholder interviews*

Internal Strengths	Internal Weaknesses
E3 Production of carbon negative crops [Spain]; E6 Provide products for different markets (biofuel (Carinata, Camelina), for feed, supplements, food (Camelina)) [Italy]; E7 Cascading value chains [France]; E8 Double market (feed and fuel) [France]; E9 Incremental value adding crop [France]; E13 Camelina and Carinata are grown in rainfed conditions [Spain]; E16 Highly resilient and adaptable oilseed crops, minimal rainfall, medium agricultural input requirements [Spain]; E17 Camelina and Carinata work well as secondary crop, [Italy]; E19-21 Can be grown in marginal areas, success under drought conditions [Serbia, desk research, workshop discussion]; E23 Natural pest control [desk research, workshop discussion]; E24 GHG saving [France]; E25 Soil improvement [desk research, workshop discussion]; E26 Cover crop [desk research]; E27 Reduced water consumption [Morocco]	CH7 Recently lack of a real market [Spain]; CH13 The oil (Camelina) has virtually no market, because cheaper options are available [Italy]; C14 Danger of (extreme) drought related crop failures [Spain]; CH20 Risk of lower yields regarding following crops [Spain]; CH23 During severe drought Camelina may not compete in terms of production and profitability [Spain]; CH30 Impediments to achieving the chemical characteristics of other crops [Spain]
External Opportunities	**External Threats**
E1 Intermediate crop status (listed in RED III Annex IX) [France]; E2 New possibilities for crop rotation and diversification under the new CAP [Spain]; E4-5 Growing on severely degraded lands opens up large biofuel market (incentivised by REDIII, additional income for farmers [France]; E10-12 Vegetable raw material for feed producers [Spain, Italy, France]; E14-15 Trials in energy cultivation, soil improvement, ecosystems services [Italy, desk research]; E18 Development of ingredients for supplements [Italy]; E22 Increase options of crops/crop rotations (double cropping, intercropping) [Morocco]; E28 Existing oil producers have the necessary equipment and infrastructure available [France]	CH1 Absence of consistent agricultural policy and support [Serbia]; CH2 Unregulated market, volatile market prices [Morocco]; CH3 Restrictions of the CAP (e.g., restriction for herbicide application) [Spain]; CH4 No policy to provide financial assistance to farmers during drought seasons [Morocco]; CH5 Subsidies/tax rebate/agricultural credits provided by the government may not be sufficient [Morocco]; CH6 Missing government support for cooperatives [Morocco]; CH8: Lack of money for investments [Morocco]; CH9: Rising production costs (e.g., personnel, fertiliser) and inflation [Spain]; CH10: Difficult market situation (selling prices for products too low), no or low profits [Spain]; CH11: Difficult introduction of low revenue product [Spain];

	CH12: Hard to approach the agri-food world because massive quantities required for test trials [Italy]; CH15 Cost of cultivation is increasing [Morocco]; CH16 Camelina is not a typical culture [Italy]; CH17 Lack of knowledge about Camelina and Carinata [Spain]; CH18: Workforce is missing, generational problem [Serbia]; CH19: Political framework (e.g., CAP] that would sustain Camelina cropping has been confronted by farmers [Italy]; CH21-22 Cooperative/storage agencies are not all equipped and trained for Carinata and Camelina [France, Spain] CH24 Problems occurring with lepidopteran feeding on the flowers of Carinata [Spain]; CH25 Extreme climate as well detrimental for Carinata and Camelina [Sain]; CH26 Missing availability and permission of pesticides and herbicides [Morocco]; CH27-28 Information gap regarding viable and cost-effective plant protection [Spain]; CH29 High level of administration and bureaucracy [Serbia] CH31: Lack of infrastructure for supplemental irrigation [Morocco] CH32: Lack of storage infrastructure. [Morocco]

*Enablers (E1-28) and challenges (CH1-32) as provided by each individual country (Table 14-15)

6.1 Using Internal Strength to Capitalize on External Opportunities

(1) Expand market reach: Collaborate with industry and producer networks to establish robust value chains targeting Sustainable Aviation Fuel (SAF) and biofuel markets, while utilizing by-products for food, feed, and biobased-products applications.

(2) Promote ecosystem benefits: Highlight the biodiversity and water management improvements in semiarid or severely degraded (marginal) areas as compared to fallow land achieved through Camelina and Carinata cultivation. Leverage these benefits and those from environmental directives & incentives, to attract young, innovative farmers interested in new sustainable business models.

(3) Increase supply chain efficiency: Beyond the successful crushing process development of large volumes of Carinata, seed companies need to develop short-cycle varieties suitable for large-scale production.

(4) Promote dual-purpose cultivation: Highlight Carinata and Camelina's adaptability to marginal lands and their potential to improve soil quality, while leveraging bioeconomy funding programs such as Next Generation Funds.

(5) Integrate into rotational cropping schemes: Leverage their ability to act as intermediate crops (e.g., between spring and summer food crops) to improve soil quality and align with Common Agricultural Policy (CAP) measures promoting diversification.

(6) Explore added-value products from Camelina cake: Develop pharmaceutical and animal feed applications, offering fattening animal feed and sustainable alternatives.

(7) Expand the biofuel market via existing infrastructure: Utilize existing oil extraction facilities and partnerships with large industries to guarantee demand for Carinata while promoting Camelina's biofuel potential.

(8) Develop localized biofuels and by-product markets: Enhance the proximity of raw material use and end-consumer access, minimizing logistical costs and fostering regional substitution of fuel by biofuel.

(9) Repurpose existing infrastructure: Locate new Carinata and Camelina-related activities within existing warehouse facilities used for storing agricultural products, as this location was considered more viable than making new investments in land, far from the cooperative.

(10) Diversify value streams through segregated supply chains: Establish traceable supply chains for Camelina oil - allocating primary fractions to advanced biofuels (e.g., SAF) under REDIII, while exploring its potential as an Omega-3 rich edible oil in health-focused products through separately certified batches, without compromising its non-food crop classification.

(11) Improve oil quality through targeted supply chains: Establish optimized supply chains that focus on enhancing oil quality to encourage wider crop adoption and strengthen market confidence.

(12) Enhance marketability through ecological benefits: Leverage Camelina's contribution to soil health and ecosystem balance to qualify for CAP contributions and carbon certification programs.

(13) Integrate with traditional crops: Introduce Carinata and Camelina to be grown in marginal lands or as intermediate crops in rotation with main crops.

(14) Unite small farmers: To reduce costs and improve production form cooperatives to add values for their products and provide employment for local and rural communities. Need to build institutions that provide employment, support development of agriculture. Form a cooperative to solve issues in agricultural practice. Form a multifunctional cooperative to add value and find a market.

(15) Develop cascading value chains: multi-level value chains (e.g., advanced biofuels / SAF→ feed→ supplements→ bioherbicides; feed into food-grade oils/extracts (Omega-3 products).

(16) Promote sustainable agronomic practices: Highlight the possibility of sustainable fertilisation, crop rotation, and pest management.

(17) Provide empirical evidence on soil health benefits: Evaluate soil health potential with on-field primary data on soil benefits (e.g. increase of SOC, AGB, BGB, WHC) and spark interest in the crops.

(18) Leverage Camelina's and Carinata's contributions to mitigate climate change to qualify for RED contributions/incentives as an intermediate crop to be grown in between main crops or on marginal land (clarify definition of marginal land in all EU and non-EU countries).

6.2 Using Internal Strength to handle External Threats

(19) Support clear decarbonization standards: Use Camelina and Carinata's grown as intermediate crops non-food status and sustainability advantages to advocate for explicit definitions in SAF decarbonization strategies.

(20) Combat depopulation through resilient farming models: Encourage the cultivation of Camelina and Carinata in marginal lands to provide income and sustainability benefits, counteracting depopulation trends in rural areas.

(21) Mitigate drought risk with crop resilience: Leverage the drought tolerance and adaptability of Camelina and Carinata to ensure productivity despite increasing water restrictions and climate instability.

(22) Utilize cover crops to address biodiversity concerns: Promote Carinata's ability to quickly cover soil in winter and Camelina's environmental benefits to align with societal concerns about biodiversity.

(23) Enhance farmer engagement through fast-growing cover crops: Utilize Carinata's rapid winter growth to prevent soil erosion and nutrient loss, addressing farmer concerns about profitability in marginal areas

(24) Bringing innovation in the countryside is fundamental, if there are also operators and practitioners engaged in promoting innovation linked with evidence, it might be an advantage, and knowledge might spread in a shorter time.

(25) Combine tradition and innovation, find cultures, that combine with traditional ones.

(26) Cooperative should seek help in the future from the relevant governing agencies & ministries

(27) Explore progressive farmer growing cereals, vegetables, olive trees, … (and add Camelina and Carinata as another option in the crop rotation for double cropping/intermediate cropping).

(28) Conservation agriculture (incl. drought tolerant Camelina) may help overcoming effect of drought by increasing soil cover and soil organic matter.

(29) Transfer of knowledge and close communication with agricultural producers and agricultural expert services that are connected to the regional administration.

(30) If the soil is contaminated, energy plants are suitable for remediation (phytoremediation).

(31) Promote direct-to-consumer sales of non-oil Camelina by-products: Develop short supply chains for agricultural co-products—such as Camelina meal or biomass—by enabling direct sales to citizens without intermediaries. This approach supports local economies and circularity..

(32) Marginal land which inherit soils with a lower potential for growing food crops (with high nutrient and water demand) can be used to grow (low demanding, robust, drought resistant) industrial crops (for fuel/materials) that are not used as food.

6.3 Using External Opportunities to Mitigate Internal Weaknesses

(33) Engage farmers and co-ops: Use producer networks and seed companies to reduce farmer hesitation by offering financial support and market incentives for Camelina and Carinata adoption.

(34) Promote market readiness: Address storage and crushing capacity weaknesses by ensuring cooperatives and processors are ready to handle Camelina and Carinata at scale.

(35) Incentivize sustainable practices: Create new programs that reward farmers for sustainability practices, offsetting potential yield and price challenges associated with regulatory compliance.

(36) Invest in research for diversified uses: Address the lack of research by targeting funding from bioeconomy initiatives to explore pharmaceutical, feed, and bioproduct applications for Camelina and Carinata.

(37) Market alternatives to fossil fuels in marginal areas: Use Carinata and Camelina as carbon-negative crops on drylands, capitalizing on their resilience and the related funding for sustainable energy solutions.

(38) Establish public-private partnerships to strengthen the supply chain: Promote collaborative networks involving fuel and feed companies, government initiatives, and local stakeholders to address the lack of industrial-scale processing and market access for Carinata and Camelina..

(39) Cooperativism should be one of the keyways to jointly develop this type of crops, guaranteeing seed, sharing machinery, storage facilities, knowledge, having advisory services, inputs and the subsequent commercialisation of production.

(40) Strengthen farmer collaboration to build supply chains: Establish consortia or cooperatives to support Camelina as an intermediate crop in rotations, benefiting from European policy incentives like CAP contributions.

(41) Circular economy approach for cost reduction: develop by-product valorisation strategies for Camelina cake in animal feed and other uses to offset high production costs.

(42) To build a value chain, add value get better price and create employment. Enhance solidarity between farmers to support modern agriculture and develop the new cropping system and related infrastructure.

(43) Promote awareness and market development for Camelina & Carinata-based value chains: Create opportunities to showcase the crops and their applications—particularly in advanced biofuels and co-products— through international exhibitions and targeted outreach. Support local market engagement for non-oil by-products ensuring alignment with REDIII..

(44) Production of seeds on larger areas.

(45) Respect doses, withholding periods, order of mixing preparations, cleaning and maintenance of devices, and disposal of packaging to improve plant protection processes.

(46) Marginal land provides potential for preserving diversity that has not been used or supported at a higher level in many countries.

(47) Create association of (small) agricultural producers and sharing the knowledge and experience gained in production by experienced farmers (direct connection to regular customers develops a sense of security among the associated producers, strengthens consumer awareness of food quality and connection in the community).

(48) It is necessary to finance with own funds and as well explore European Union/International incentives.

6.4 Minimize Internal Weaknesses and Avoid External Threats

(49) Strengthen policy advocacy: work with stakeholders to streamline CAP and Nitrate Directive classifications, reducing regulatory uncertainty.

(50) Develop tailored solutions for marginal lands: Address the lack of profitability and definition of marginal lands by partnering with policymakers and researchers. Identify land use categories and related suitable farming practices.

(51) Target niche biofuel and bioproduct markets: Minimize reliance on low-margin sectors by focusing on higher-value niches like aviation biofuel and bioplastics while navigating regulatory barriers.

(52) Foster collaborative farming models to sustain small farms: Encourage the formation of cooperatives or partnerships to maintain profitability and resist the displacement of small and medium-sized farms.

(53) Implement precise farming techniques for better crop management: Address issues like Camelina's small seed size and nascence problems by promoting precision sowing and tailored soil preparation methods.

(54) Collaboration of farmers in a consortium to switch crops towards more profitable alternatives, collaboration with a company to produce high-quality seeds.

(55) Innovative farming models: Provide technical and financial support to farmers transitioning to Camelina, helping to overcome the lack of generational change and traditional resistance.

(56) Foster producer cooperatives to strengthen market access and certification: Encourage collaboration among producers to form cooperatives that address certification challenges and improve market access for Camelina and Carinata. Focus on non-food value chains—particularly advanced biofuels and co-products—while enabling local sales of non-oil by-products, ensuring compliance with REDIII sustainability and traceability requirements..

(57) Working with other cooperatives, in voluntary and democratic manner, with no profit and no loss basis, particularly to sell the products outside and for the development of infrastructure.

(58) Involve government (by concerned effort of cooperatives) to support infrastructure development and support education projects.

(59) Produce bioproducts which are good for human health and the environment (increase biodiversity).

(60) Training the "weak" cooperatives, start campaigning and education programs.

(61) Actively get involved in all institutional and political bodies that can contribute to solving the challenges. Organizing into a larger institutional body (cooperative association) that can cause changes.

(62) Community supported agriculture as a new way of agricultural production that is in line with social interests (health, clean environment, contribution/involvement of the local community.

7. Key Messages

S × O (Internal Strengths × External Opportunities)

Build Integrated & Diversified Value Chains: Provide opportunities for farmers to form or join cooperatives and use existing infrastructure to develop full chains from biofuel to feed and non-food applications, creating local and regional markets.

Leverage Ecological Benefits for Incentives: Promote Camelina and Carinata's soil, biodiversity and climate services to align with CAP/RED/carbon schemes, attract innovative farmers, and secure funding.

S × T (Internal Strengths × External Threats)

Position as Resilient, Climate-Smart Crops: Use drought tolerance, marginal-land suitability and cover-crop benefits to counter biodiversity loss and soil erosion.

Shape Standards & Spread Innovation: Advocate for clear decarbonization and marginal-land definitions while integrating sustainability benefits, tradition and new rotations to accelerate adoption.

W × O (Internal Weaknesses × External Opportunities)

Strengthen Farmer Collaboration & Infrastructure: Create consortia and public-private partnerships to share machinery, storage, knowledge and market access; finance crushing facilities and by-product valorisation.

*Use Incentives & Local Markets to Offset Risks***:** ap EU/national programs to reward sustainable practices, diversify products and open local/regional sales channels for non-oil by-products.

W × T (Internal Weaknesses × External Threats)

*Build Cooperative & Policy Capacity***:** Form and train strong cooperatives, engage in institutional bodies and campaigns to secure certification, infrastructure and education support.

*Target High-Value Niches and increase farming expertise***:** Focus on aviation biofuel, bioplastics and natural bioproducts while adopting farming expertise for Camelina and Carinata to overcome technical and profitability challenges.

8. Discussion

In the past decades, several campaigns were launched to introduce new crops and related products into the agricultural sector and related markets. Targeted markets were the biofuel, biogas, and food and feed market. However, the market implementation of some of these crops and products has failed for several reasons[1]. In certain cases, the information base was insufficient; in others, marketing concepts were not accepted by the broader farming community. Additional challenges included the absence of established downstream markets, premature market entry, or a lack of local capacities for production, storage, and processing. Such problems should be avoided through a comprehensive analysis of the macro-environment. Carinata and Camelina are new biomass sources that can provide feedstocks for the circular bioeconomy with low or negligible Indirect Land Use Change (ILUC) effects[2]. Inserting these crops into crop rotations or growing them on marginal, abandoned, and degraded lands is aligned with objectives[3] outlined in the EU Renewable Energy Directive (RED) and can lead to a significant push for their development. For this to become a reality, clear certification criteria should be set for intermediate crops. However, the concept of marginal land remains ambiguously defined. Attempts have been made to map such areas based on several factors such as climatic conditions, chemical properties, fertility, rooting conditions and topography[4].

A central question addressed in Task 5.3 is how social innovation can support the implementation of the CARINA crops. Stakeholders from different groups — reflecting their backgrounds, roles, and motivations (Tables 1–12) — expressed diverse perspectives on the introduction of Carinata and Camelina. These insights, categorized as enablers and challenges (Tables 14-15), illustrate that responsible social innovation solutions can support acceptance of these new crops and products if they provide mutual benefits for both farmers and society.

The PESTEL+I (Table 14-15) and SWOT/TOWS analysis (Table 16, 6.1-6.4) has provided a comprehensive overview of factors at a certain point in time (2023-2024) that may influence the implementation of advanced biofuel projects based on Camelina and Carinata. However, it is important to note that some stakeholder perceptions may reflect incomplete or outdated interpretations of EU legislation, particularly REDIII. For example, the production of advanced biofuels from these oilseeds does not compete with food crops, as they are used as intermediate crops between food crops, or cultivated on marginal, abandoned, or severely degraded lands, as explicitly recognized under REDIII. Both production strategies are excluded from land designated for food or feed use under current legislation. These clarifications are essential to ensure an accurate assessment of risks and opportunities in the development of the circular bioeconomy.

Based on the stakeholder survey findings from Task 5.3, several solutions and strategic directions have been proposed within the CARINA project. The following examples illustrate selected perspectives collected from the participating countries:

1 https://www.mdpi.com/2071-1050/6/6/3213

2 https://www.iscc-system.org/news/certified-low-iluc-biofuel-a-solution-for-degraded-land/

3 https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en

4 https://storymaps.arcgis.com/stories/1fc7bc04a175441eb0443b17f0417944

“We want to aggregate small farmers to reduce costs and improve production.”

According to Moroccan farmers, the formation of multifunctional cooperatives could add value to local products and create employment for local and rural communities. The opportunity to better solve issues in agricultural practice is another advantage of cooperative work and foster institutions development of agriculture and cooperatives in Morocco. [Moroccan farmer]

“*Camelina sativa* and *Brassica carinata* are crops which allow harvesting of oilseed between two other crops.”

A French farmer noted that introducing intermediate industrial crops brings additional value and incomes, but requires integration into existing cropping system, to avoid negative impacts. Farmers and end users must be trained to select appropriate previous crops and suitable pedoclimatic conditions for Camelina production as second crop and to develop short cycle varieties. Information events, field days, and demonstration trials will support knowledge dissemination and correct and sustainable implementations. [French farmer]

“The progressive disappearance of small and medium-sized farmers at the hands of investment funds and companies detached from the agricultural sector is a sensitive problem.”

An agronomist and technician in Spain warned that this trend underscores the need for support to preserve small-scale farming structures. [Agronomist and technician in the agronomic service, Spain]

“Generational replacement in plant production and livestock farming is a major challenge.”

Because Camelina and Carinata are rainfed crops, they can help retain local populations, as cultivation options are increased. The changes in climate and rainfall that have occurred in recent years show us that it is necessary to look for alternative crops to deal with the consequences of climate change. In this case, Camelina and Carinata provide an opportunity as they seem to be more robust in hot, dry areas, and as they are fast crops with which the sowing date could be delayed. [Researcher at Technology Centre, Spain]

“Networks of producers give farmers a voice to participate in designing new value chains.”

French farmers highlighted that for a fair and equitable distribution of value in the value chain, farmers must be considered first. [French farmer]

“Any incremental value-adding crop improves self-sufficiency of farmers”

Additional income from crops like Carinata or Camelina strengthens farmers’ economic resilience, particularly by enhancing feed self-sufficiency (e.g. for feed production). [French farmer]

“In Serbia, organic production associations operate according to the principle of community-supported agriculture as a model for connecting agricultural producers and consumers and as a good practice that offers the opportunity to build mutual trust between them.”

A direct connection to regular customers develops a sense of security among the associated producers, strengthens consumer awareness of sustainable practices and connection in the community. [Member of Faculty of Agriculture, University, Serbia]

“An agricultural company in Italy is trying to manage its impact on the community in the best possible way. They use about 10% of the farm area for environmental restoration, manage 30% of the farms with the organic method to have a positive impact on communities.”

The actions they are going to introduce seek to maintain a minimum of biodiversity which is in the economic interest of the farm. The fact that they do not use chemicals is important for the society, both for the operators and for the inhabitants living near the cultivated fields. [Italian farmer]

9. Conclusions

The transition to a more sustainable and socially accepted agricultural system is an ongoing process in which the introduction of new crops, cropping systems, and innovative technologies undoubtedly plays an important part. However, before and during introduction of such new systems, stakeholders must be adequately informed and actively involved. Without such inclusion, new systems are unlikely to endure, whether due to unsuitable pedoclimatic environments, lack of infrastructure and markets, or insufficient acceptance of farmers and customers.

In the presented research, several enablers and challenges were identified through semi-structured interviews with stakeholders from all relevant groups (Tables 14-15). Among the most important enablers are policy incentives under the CAP — such as measures supporting. crop diversification and crops with negative carbon balance — and the RED, which promotes the use of intermediate crop and those cultivated on severely degraded lands. Furthermore, several markets could be explored through cascading value chains that integrate applications in sustainable fuel and biobased products.

Conversely, the main challenges identified by respondents include inconsistent agriculture policy, missing support for cooperatives, high production costs, generational problems, non-existent real market and low expected profits for the new crops such as Camelina and Carinata.

As expected, many answers revealed a lack of understanding and information on Carinata and Camelina, their agronomic characteristics and the EU rules applicable to them. This project aims to contribute to mitigate this and help stakeholders throughout the value chain to better understand the features of these crops, as well as their potential to improve agriculture productivity, while generating additional sources of revenues for farmers.

Cooperatives can organize training and educational activities, facilitate demonstration trials, and promote knowledge exchange on best agronomic practices adapted to local environmental conditions. They also enable shared access to infrastructure and equipment, thereby reducing production costs, and can manage commercialization processes, including certifications, contracts, and logistics.

Cooperatives and farmers associations are one of the most frequently proposed forms of social innovation by farmers and other stakeholders as a model to solve some of the current issues and challenges. Stakeholders highlighted that such collective structures address multiple challenges simultaneously, they could provide trainings and education, demonstration trials, events, and prepare farmers for the best management of the new crops in their own environmental settings; supporting acceptance and knowledge collection and transfer. Expensive infrastructure and

equipment could be shared by all members of the community or cooperative which could lower production cost. Commercialisation processes can also be organised by cooperatives, including certifications, permits and contracts with customers.

Beyond economic advantages, cooperatives enhance community resilience by allowing members to collectively respond to climate change impacts, geopolitical disruptions, and market fluctuations, which can be better managed by the whole community of the cooperative than by a single farmer or small agronomic enterprises. Especially important is the spread of knowledge on opportunities and incentives created by EU and local government which may not well known or understood by many small farmers.

To achieve broad acceptance and sustainable integration of the CARINA crops and related cropping systems, continuous promotion, communication and demonstration are required within local communities. Emphasizing the ecological benefits of Camelina and Carinata — such as their contributions to biodiversity enhancement, soil protection, and carbon sequestration — can further foster social innovation and garner acceptance for the transition towards a more circular and resilient bioeconomy.