D6.4

Practice Abstract - Batch 1

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V7	04/09/2024	PA inclusion	UNIBO
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NOTICE

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ABBREVIATIONS

iLUCS	Indirect land use change impacts
PA	Practice abstract
WP	Work package
GLS	Glucosinolate
EU	European Union

1. Executive summary

The CARINA project, under the auspices of the EU's Horizon Europe programme, aims to develop sustainable production systems that are also economically viable. The project focuses on new sustainable and diversified farming systems including two new oilseed crops, carinata and camelina, able to provide multiple low iLUC feedstocks for the bio-based economy.

A participatory approach is deemed essential for successfully scaling up these innovative farming systems. The project highly values the involvement of farmers and other stakeholders in jointly developing solutions tailored to specific environmental, technical, and social conditions.

This report aims to present the objectives of CARINA activities in the shape of practice abstracts (PAs), which will be also shared at the EU-CAP Network. Practice abstracts (PAs) are short summaries that present the activities and practical developments throughout the project and enable contacting partners and incentivise efficient knowledge exchange.

This report also aims to reach a broader audience beyond the immediate project stakeholders, highlighting the significance of disseminating and sharing the outcomes of the CARINA project.

2. Introduction

To foster collaboration with other organizations and facilitate the sharing of results, the European Commission has launched a new platform, the EU CAP Network, to replace EIP-AGRI. This platform provides access to publications from various projects and programmes dedicated to the development of the primary sector, with a particular emphasis on the implementation of more sustainable agricultural practices.

The Horizon Europe programme, which succeeds Horizon 2020, has as its primary objective the sustainable development of agricultural, rural, and forestry areas. It supports research and innovation aimed at modernizing various processes within these sectors. This programme is distinguished by its support for multi-actor projects, recognizing that cooperation among entities and the distribution of tasks significantly enhance the likelihood of project success.

The CARINA project, funded under the Horizon Europe programme, is founded on a consortium dedicated to advancing more sustainable agricultural practices. Camelina and carinata have been selected as the crops for implementation in this project, contributing to diverse iLUCS feedstocks for the bio-based economy. These crops are chosen for their ease of cultivation and low requirements for water and fertilizers, presenting a viable solution to engage farmers in the project.

The production of oil from camelina and carinata aims to create bio-products such as bioplastics and bio-herbicides. Additionally, the byproduct of oil extraction, known as the cake, will be utilized as animal feed. The project's goal is to reach approximately three million farmers with the support of all associated organizations, including those in the European Union and North Africa, where soil and climate conditions are favourable for these crops.

In order to present all these objectives in a comprehensive and synthesised way, this report compiles the main activities foreseen in the project in the form of seven practice abstracts (PAs), as well as the main characteristics of the camelina and carinata crops. Therefore, the purpose of these PAs is to provide final users with a clear understanding of the project's structure, objectives, and the results or conclusions derived from each activity.

All this information has been compiled adhering to the format and structure guidelines defined by EU-CAP.

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CONTRIBUTING PARTNERS	SHORT NAME
ARVALIS INSTITUT DU VEGETAL	ARVALIS
DBFZ DEUTSCHES BIOMASSEFORSCHUNGSZENTRUM GEMEINNUTZIGE GMBH	DBFZ
PEDAL CONSULTING SRO	PEDAL
COOPERATIVAS AGRO-ALIMENTARIAS DE ESPANA U DE COOP SOCIEDAD COOPERATIVA	Spanish Co-ops
KIMITEC BIOGROUP SL	KIMITEC
CAMELINA COMPANY ESPAÑA	CCE
NUSEED EUROPE LTD	NUSEED

3. Methodology

Practice abstracts (PAs) are concise summaries, approximately 1000 - 1500 characters in length (Microsoft Word count without spaces), which outline the key information and recommendations, aiding end users in their daily practices. Each PA has been created in accordance with the EU-CAP Network guidelines and Common Format (see Figure 1). Additionally, every PA should include a brief title.

The summaries are expected to include the following details:

- Objective: what problems/opportunities does the project address that are relevant for the practitioners/end-users, and how will they be solved?
- Result: which are the main outcomes of the project?
- Recommendations: How can the end-users (e.g. farmers) make use of the results in practice? What would be the main added value/benefit/opportunities to the end-users if the generated knowledge is implemented?

Both the summary and the title must be provided in English language, which will be automatically translated into 24 official EU languages within the EU-CAP Network.

Figure 1- PA's guidelines.

Following the transition from EIP-AGRI to the EU-CAP Network, several changes have been implemented regarding the delivery and review of projects. The EU-CAP Network portal now allows for project submissions after they have been reviewed by the European Research Executive Agency (REA). Once a project is uploaded, it undergoes a review process focusing on format and structure, provided the content has already been reviewed by the REA. Upon successful completion of this review, the set of PAs are approved for publication.

4. List of practice abstracts

The following list of PAs (see Table 1) summarises the main activities of the CARINA project performed within the different Work Packages (WPs), as well as the main characteristics of the camelina and carinata crops. Therefore, the purpose of these PAs is to provide final users with a clear understanding of the project's structure, objectives, as well as the available results or conclusions derived from each activity.

NUMBER	TITLE	RESPONSIBLE PARTNER
PA1	*Camelina sativa* and *Brassica carinata* in sustainable cropping systems	ARVALIS
PA2	Full biomass valorisation with a circular economy approach	KIMITEC
PA3	Integrated sustainability assessment of CARINA bio-based production systems	DBFZ
PA4	Co-creation of policy interventions for feedstock provision and certification	UNIBO
PA5	Sustainable bio-based agricultural systems through social innovation	Spanish Co-ops
PA6	*Camelina sativa* – Introduction of the crop	CCE
PA7	*Brassica carina – Introduction of the crop*	NUSEED

Table 1- List with the practice abstracts

1. *Camelina sativa* and *Brassica carinata* in sustainable cropping systems

One of the objectives of the CARINA project is to design and implement new site-specific primary production systems at farm scale. The new systems will be thoroughly analysed within the lighthouses to co-create and develop innovative and sustainable technical solutions.

In this line, three ways of production of *Camelina sativa* and *Brassica carinata* have been studied within the framework of the project. Both crops are being tested in double cropping systems as winter or summer intermediate crops, in intercropping systems with a companion crop, or as intermediate crops replacing fallow periods on marginal lands.

A total of 158 trials of these two oilseed crops were carried out in Bulgaria, Spain, France, Greece, Italy, Morocco, Poland, Serbia, and Tunisia. Additionally, 28 demonstration field days were organized to discuss these trials with local stakeholders such as farmers, seed companies, practitioners, and cooperatives. The initial results show a good potential for the development of camelina and carinata on marginal lands. Likewise, the crops such as summer or winter intermediate crop in a double cropping system seem promising. Nevertheless, the growth cycle of carinata appears to be too long when sown in autumn to allow for the seeding of a following summer food crop. Regarding intercropping, various companion crops have been tested, such as peas and lentils, showing encouraging results.

However, several technical challenges need to be addressed, such as seeding density balance, crop protection, and harvest management.

The work will continue within the project, allowing for the improvement of farming practices for each system studied, the selection of the best one and also of the best crop according to specific soil and climatic conditions.

2. Full biomass valorisation with a circular economy approach

CARINA project aims to valorise the co-products of carinata and camelina through the extraction of molecules having different applications in the field of bioplastics, biochemicals, animal nutrition, biofuels, biostimulants and/or biopesticides.

During the first period of the project, the physical and chemical characteristics of *Brassica carinata* and *Camelina sativa* seeds have been analysed. The results showed that carinata seeds contain higher levels of erucic acid than camelina. Consequently, carinata oil is used to produce dicarboxylic acids and laboratory-scale tests have confirmed the feasibility of producing biochemicals with applications in bioplastics and biopesticides.

Another aim is to determine the optimal incorporation rate of camelina and carinata cake (2% to 20%) in animal feed. Trials are being conducted, including zootechnical, palatability, and digestibility tests. An additional project aim is to reduce glucosinolate (GLS) levels (an antinutritional factor) through heat treatment.

Another goal is to valorise GLS extracts from carinata seeds for potential use in biocides or phytosanitary agents. Challenges have been encountered in scaling up GLS extraction but expected to be resolved soon. Project partners have also evaluated camelina cake polysaccharide as a stabilizing agent for nutraceutical formulations. This polysaccharide extract, obtained on a laboratory scale, has been investigated for enhancing the bioaccessibility of bioactive molecules.

Finally, various technological approaches (enzymatic hydrolysis, ethanol extraction, fermentation, pyrolysis, etc.) are being applied to different co-products to develop biostimulants and biopesticides.

3. Integrated sustainability assessment of CARINA bio-based production systems

Among the various objectives of the CARINA project, one is to carry out an integrated sustainability assessment of CARINA bio-based production systems, including the identification of sustainability indicators for the assessment of the economic, social and environmental impacts.

The assessment aims to determine the sustainability contribution of CARINA concepts and promote the successful implementation of agro bio-based systems for carinata and camelina. To address the complexity of modern agri-food systems and their potential impacts on society, environment, and economy, CARINA employs a life cycle approach to measure and quantify the performances and risks of the novel CARINA systems.

This methodology enables the identification of hotspots and trade-offs in social and environmental impacts. Furthermore, the economic aspects are considered through the potential benefits and total costs associated with the implementation.

The cohesive integrated sustainability assessment encompasses three main components: Social Life Cycle Assessment (SLCA), Life Cycle Assessment (LCA), and Cost and Benefit Analysis (CBA) as well as system integration aspects.

This multifaceted approach provides an overarching understanding of the contribution of CARINA concepts to various aspects of sustainability, while also considering the integration potential and limitations of bioeconomy concepts.

The results of the integrated sustainability assessment allow to understand the full contribution of CARINA concepts to the system and enables a comparison with current and alternative concepts and practices, ultimately informing decision-making processes and promoting sustainable bio-based systems.

4. Co-creation of policy interventions for feedstock provision and certification

The objectives of the CARINA project include the development of policy recommendations and the discovery of synergies in sectoral strategies for the provision of certified low iLUC feedstock for bio-based value chains.

The activities revolve around the definition of tools and frameworks for analysing policy landscapes, focusing on innovative agricultural systems, certification schemes and methodologies for monitoring, reporting and verification (MRV). The research group shaped policy factsheets for the countries in which the camelina and carinata value chains are more mature – Spain, France, Italy and Germany – to support policymakers and practitioners in exploring, assessing, and improving existing policies.

Moreover, Policy Innovation Labs (PILs) have been carried out to engage stakeholders in the identification of policy gaps and opportunities, ensuring that the recommendations are practical, relevant, and aligned with sector needs, both upstream – farmers, seed producers, cooperatives – and downstream – transformation industry.

The project also plans foresight workshops for ex-ante impact assessments of policy interventions, building on macro-level modelling to provide insights into the optimisation of supply chains and the minimization of land use conflicts. The exploration of trade-offs will support policymakers in defining supporting policy environments and identifying efficient mitigation strategies to tackle negative externalities. By integrating these results with social innovation frameworks, the project supports the development of policies that drive sustainable agricultural practices and enhance the bioeconomy, offering actionable insights and tools for end users.

5. Sustainable bio-based agricultural systems through social innovation

Another objective of the CARINA project is to enhance the understanding of barriers and potential risks to upscale bio-based agricultural production systems through a multi-actor social innovation process. In this line, one of the first steps was to establish national Living Labs (LLs) in Italy, France and Spain**,** involving in them stakeholders representing the whole value chain (farmers, cooperatives, agronomic advisers, policy makers, farmer unions, academia, policy makers, bioindustries, etc.).

The synergies between the CARINA and other European projects were an opportunity to carry out interactive surveys to explore the participants' knowledge of the entire "ecosystem" of camelina and carinata cultures. Through the first results of the LLs, it was possible to identify that the carinata crop is unknown to most farmers, that more activities are needed to raise awareness and that both crops are almost 100% dedicated to the production of biokerosene.

Furthermore, to pinpoint relevant actors and experts from the EU and North Africa involved in various stages of the value chains, stakeholder factsheets were created. The interaction with these experts includes visits to field trials, as well as interviews and questionnaires, allowing the identification of barriers that need to be overcome in order to establish new value chains (alternatives to biokerosene). A preliminar PESTEL+I analysis has provided a comprehensive understanding of the external factors affecting the implementation of these new value chains.

Next steps are focused on the elaboration of country-specific roadmaps and business plans that will be communicated to key actors to facilitate new alliances for upscaling camelina and carinata bio-based production systems.

6. *Camelina sativa* – Introduction of the crop

Camelina sativa is being tested within the framework of the CARINA project in double cropping systems as a winter intermediate crop and as a summer intermediate crop, in intercropping systems with various companions' crops (mostly pea but also barley, lentil, chickpea and lupin), or as intermediate crop cultivated on marginal lands replacing fallow periods.

Intercropping system reveals to be the most challenging regarding seeding density balance, crop protection, and harvest management. Some key aspects of the crop and the key points of the protocol for its cultivation in the conditions of Spain are summarized in this Practice Abstract.

Facts

- Common name: Camelina, Leindotter, Gold of Pleasure, False Flax.
- Scientific name: *Camelina sativa* (L.) Crantz.
- Family: Brassicaceae or Cruciferae.
- Drought-resistant oil crop with a yield potential of 2.5 t/ha.
- Plant height: 60 to 120 cm.
- Pollinator friendly species.
- 1000-seed weight: 0.8 - 1.6 g.

Advantages

- Works with conventional machinery for winter cereals.
- Easy implementation & low-input crop.
- Adapts and grows well in different environments and regions.
- Catch crop.
- Pest & disease tolerant.
- Pivoting root - soil structure improver.
- Different cycle length varieties are available.
- Excellent crop in rotation with cereals.

Agronomic protocol key points

- Plots: Avoid easily waterlogged soils, with crust formation and pH < 5.5 and > 8.5.
- Sowing: Shallow sowing (≈ 1 cm) in rows (12.5 -15 cm distance) on a plot without weeds or straw.
- Nutrients: Guarantee minimum nitrogen availability including soil N (60 units/ha).
- Herbicides: Check residual herbicides (mainly ALS & PDS).

7. *Brassica carinata* – Introduction of the crop

Brassica carinata is being tested within the framework of the CARINA project in double cropping systems as a winter intermediate crop and as a summer intermediate crop, in intercropping systems with various companions and as summer intermediate crop cultivated on marginal lands replacing fallow periods.

Some key aspects of the crop and the key points of the protocol for its cultivation in the conditions of Serbia are summarized in this Practice Abstract.

Facts

- Common name: Carinata, Abyssinian cabbage or Ethiopian mustard.
- Scientific name: *Brassica carinata* (A.) Braun, Family: Brassicaceae.
- Harvested non-food oilseed, outcompetes many winters weeds.
- Yield potential: 1,5 - 2,5 t/ha.
- Plant height: 1,45 m.
- Blackleg and pod shattering resistant.
- Cold, heat, and drought tolerance.
- Low rates of seed shattering.
- Non-GMO.
- Pollinator friendly species.
- TKW: 5,78 g.

Advantages

- Works with common planting equipment/methods for small seeds.
- Easy implementation & low-input crop.
- Adapts and grows well in different environments and regions.
- Excellent pivoting root system improves soil structure.
- High above and below ground biomass provides competitive soil cover.
- Lodging resistance: very good at moderate to low sowing densities.

Agronomic key points

- Carinata can be planted in all soil types, but does best in well-drained soils, preferred pH is 5.5 – 6.8.
- Direct seeding is ideal into low to medium stubble.
- Avoid fields with high wild radish populations (>10%), very competitive and difficult to control.
- Sowing density: 3-4kg/ha, depth: 1-2cm, interrow distance 20 – 40 cm.
- Nitrogen fertilization, max 60 units/ha including soil content.
- Does not tolerate ALS or PPO herbicide residual.

5. Conclusions

The CARINA project, under the Horizon Europe programme, seeks to enlarge the sustainable bio-based agricultural systems, focusing on Camelina sativa and Brassica carinata crops and thus, contributing to develop a bio-based economy. To ensure the achievement of this objective, the project develops in parallel several synergistic and complementary lines of activity which have been collected in this report in the form of practice abstracts (PAs).

So far, the project's integration of *Camelina sativa* and *Brassica carinata* into sustainable cropping systems has shown promising results. Extensive trials conducted in multiple countries have demonstrated the potential of these crops to thrive on marginal lands as well as in double cropping and intercropping systems. Camelina and carinata are recognized for their low input requirements, sustainability, and resilience, making them ideal candidates for sustainable agricultural systems. However, some challenges regarding the optimal seeding density, crop protection, and harvest management still need to be addressed to maximise their potential.

Even though the CARINA project has not yet reached its halfway point, the preliminary results are showing good potential for the valorisation of carinata and camelina within the bioproducts market. In this sense, progresses have been made identifying seed characteristics potential, optimising animal feed incorporation rates, and developing alternative biochemical extraction processes. Despite some challenges have been found in this regard, particularly in scaling up glucosinolate extraction, project partners are expected to successfully overcome them in the coming months, producing valuable bio-products meant to be returned into the farmers' plots in which they were produced, contributing to develop the bio-circular economy.

The integrated sustainability assessment developed within the project is providing a thorough understanding of the economic, social, and environmental impacts of these bio-based production systems. The assessment used a life cycle approach, identifying key sustainability indicators and evaluating the overall contributions of CARINA activities. This comprehensive evaluation has highlighted the significant benefits that these crops can bring to modern agri-food systems, promoting their successful implementation and scaling.

Furthermore, to support the adoption and scaling of camelina and carinata, the project has engaged in extensive knowledge transfer and stakeholder engagement. Through the establishment of national Living Labs (LLs), diverse stakeholders, including farmers, cooperative members, researchers, policy makers, bio-industry representatives, and other relevant actors have collaborated to co-create innovative solutions. This participatory approach has been crucial in identifying and addressing main challenges, such as market and economic barriers, while also highlighting the need for support to maintain competitiveness and enter new markets.

In conclusion, the CARINA project is demonstrating the viability and benefits of integrating camelina and carinata into sustainable agricultural systems. The project's holistic approach, combining technical innovation with social engagement, is paving the way for the successful implementation and upscaling of these bio-based systems. By addressing the identified challenges and leveraging the established synergies, the CARINA project is well-positioned to contribute to a more sustainable and resilient agricultural sector, offering significant opportunities for innovation and economic growth.