BRILIAN

Circular Future for Rural Areas

Resources assessment and feedstock mobilisation

Deliverable 2.2 (v1)

WP2 Deployment of local bioeconomies

Circular Bio-based Europe Joint Undertaking

Bio-based Industries Consortium

Co-funded by the European Union

The project is supported by the Circular Bio-based Europe Joint Undertaking and its members under grant agreement № 101112436. Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CBE JU. Neither the European Union nor the CBE JU can be held responsible for them.

•••

DOCUMENT TITLE: **Resources assessment and feedstock mobilisation**

DUE DELIVERY DATE: **May 31st, 2024**

NATURE: **Report**

PROJECT TITLE: Cooperative and Sustainable business models for bio-based chains in rural areas.

PROJECT ACRONYM: **BRILIAN**

INSTRUMENT: **Collaborative Project**

CALL IDENTIFIER: HORIZON-JU-CBE-2022

TOPIC: HORIZON-JU-CBE-2022-IA-02 Cooperative business models for sustainable mobilization and valorisation of agricultural residues, by-products, and waste in rural areas.

GRANT AGREEMENT: **101112436**

Organisation name of lead contractor for this deliverable:

CIRCE

DELIVERABLE TYPE		
R	Document, report	**X**
DMP	Data Management Plan	
O	Other	

DISSEMINATION LEVEL		
PU	Public (fully open)	**X**
SEN	Sensitive, limited under the conditions of the Grant Agreement	

DISCLAIMER OF WARRANTIES

This document has been prepared by BRILIAN project partners as an account of work carried out within the framework of the CBE-JU GA contract Nº 101112436.

Neither Project Coordinator, nor any signatory party of BRILIAN Project Consortium Agreement, nor any person acting on behalf of any of them:

- makes any warranty or representation whatsoever, express or implied,
  - with respect to the use of any information, apparatus, method, process, or similar item disclosed in this document, including merchantability and fitness for a particular purpose, or
  - that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or
  - that this document is suitable to any particular user's circumstance; or
- assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if Project Coordinator or any representative of a signatory party of the BRILIAN Project Consortium Agreement has been advised of the possibility of such damages) resulting from your selection or use of this document or any information, apparatus, method, process, or similar item disclosed in this document.

This project is supported by the Circular Bio-based Europe Joint Undertaking and its members under grant agreement Nº 101112436.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CBE JU. Neither the European Union nor the CBE JU can be held responsible for them.

VERSION RECORD			
Version	Name (Partner)	Description of changes	Date
V1	CIRCE	Table of content shared	January 19th, 2024
V2	CIRCE	Draft	April 29th, 2024
V3	CIRCE	Version reviewed by partners	May 14th, 2024
V4	CIRCE	Final version	May 22nd, 2024

VALIDATION	
Authors	**Reviewers**
CIRCE – Maider Gómez & Sebastián Zapata	NVMT – Gian Maria Baldi & Marta Saccomano DTI – Pablo Pillado, Angelica Tamayo & Clara Fernando DLG – Ingolf Nielsen BHCZ – Anastasia Perouli TECNO – Laura Villacián AITIIP – Carolina Peñalva PATURPAT – Ana Carrasco

EXECUTIVE SUMMARY

The first step to promote bio-based value chains is connected to the biomass assessment to identify potential biomass resources and side-streams or by-products that can be exploited for different bio-applications. The performance of the biomass assessment contributes to facilitate the assessment of the suitability of utilizing biomass for bio-based commodities. The outcomes obtained will support better-informed choices regarding the potential region that could be candidate to establish and replicate the bio-based business models developed in the pilot regions and the keys for success identified in each case.

The deliverable D2.2 summarizes all the information collected from the pilots to evaluate the potential of the feedstocks targeted in the pilot regions and BIOEAST region to produce different bio-products such as the bioplastics, vegan protein, bio-stimulants, etc. The document describes the process to design the data collection jointly with WP3, to carry out the compilation and the assessment of the data gathered, additional request of information when needed and performance of the potential assessment.

Based on the outcomes of the assessment, the regions with the highest potential to replicate the Spanish pilot business model are in Spain, France, Belgium, Germany, Poland, Sweden, Netherlands, and Romania. Considering that the share of rejected material that could be valorised to extract starch is significantly higher when potatoes are processed to ready prepared products, countries where this kind of agro-industries are relevant could have a better chance to replicate the business model, Belgium for instance.

The regions with the highest potential to replicate the Danish pilot business model are located mainly in France, Denmark, Sweden, central regions in Spain and eastern countries such as Lithuania, Latvia, Estonia, Poland, Czechia, Slovakia, Hungary, Romania, Bulgaria.

The regions with the highest potential to replicate the business model developed by the Italian pilot focusing on sunflower are located mainly in Spain, France, and eastern countries such as Slovakia, Hungary, Romania, Bulgaria while the business model focusing on safflower cake shows a relevant potential to be replicated in Belgium, Denmark, France, Italy, Netherlands, Portugal, and Spain. The biomass assessment in this case was performed at NUT0 level due to the production data availability constraints at NUT2 level.

In the BIOEAST region, the most relevant crops have been identified (wheat, barley, and maize) and potential side streams and residues assessed, considering that the business models developed by the BRILIAN pilot cases could be adapted. Additionally, keys for success highlighted in each pilot could also provide valuable inputs although the feedstocks are different (straw from wheat and barley and stalk and cob from maize). These feedstocks have a very wide distribution in the European territory too and all three can be found in practically all BIOEAST region.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

BOD – Biological Oxygen Demand

BRILIAN– Cooperative and Sustainable business models for bio-based chains in rural areas

CAP– Common Agricultural Policy

CBE-JU– Circular Based Europe Joint Undertaking

COD – Chemical Oxygen Demand

HEU – Horizon Europe – the 9th framework Programme of the EC for research, technological development and innovation activities.

LCA – Life Cycle Assessment

LCC – Life Cycle Cost

LCSA – Life Cycle Social Assessment

NUTS– Nomenclature of territorial units for statistics

PBAT– Polybutylene adipate terephthalate

PLA– Poly lactic acid

RPR– Residue to Product Ratio

SCOC – Soil Organic Carbon Stock

TPS– Thermoplastic starch

WP – Work package

INDEX OF FIGURES

INDEX OF TABLES

1. INTRODUCTION

The concerns surrounding climate change, depletion of raw materials, and the energy crisis have played a crucial role in driving the investigation of alternative raw materials for various bio-applications. The transition towards bio-based materials is imperative for the promotion of sustainable development [1,2]. Therefore, efforts are concentrating for instance on the utilization of bioorganic raw materials to enrich the protein composition of items, such as curd-based bioproducts, demonstrating the potential of alternative high-protein sources. Furthermore, the advancement of biomaterials from substitute products is gaining momentum to imitate or even exceed the performance of traditional fossil-based materials, in accordance with the objectives of environmental conservation and sustainability.

The regulations implemented to uphold obligations at both European and national levels, in conjunction with the additional considerations and prerequisites within the Common Agricultural Policy (CAP), have a significant impact on the primary sector and the deployment of bio-based value chains. These regulations are designed to enhance coordination throughout the agri-food supply chain, to boost market orientation and to integrate environmental and social sustainability considerations [3,4]. The CAP reforms, particularly through mechanisms such as Cross Compliance, assume a vital role in advocating for eco-friendly practices and monitoring detrimental farm activities. Additionally, sustainability criteria, such as those outlined in the EU Renewable Energy Directive, exert influence on global endeavors, underscoring the necessity for governance mechanisms to adhere to rigorous standards. In general, these regulatory modifications play a crucial role in molding the primary sector and bio-based value chains towards practices that are more sustainable and environmentally aware.

Nevertheless, the first step to promote bio-based value chains is connected to the biomass assessment to identify potential biomass resources and side-streams or by-products that can be exploited for different bio-applications.

The performance of the biomass assessment contributes to facilitate the assessment of the suitability of utilizing biomass for bio-based commodities [5,6]. The outcomes obtained will support better-informed choices regarding the potential region that could be candidate to establish and replicate the bio-based business models developed in the pilot regions and the keys for success identified in each case. Through thorough evaluations of biomass, regions can identify potential initiatives that could be replicated and contribute to reducing fossil fuels dependance while achieving climate objectives.

Within BRILIAN, the WP2 aims to evaluate the potential adoption of valorisation schemes for the feedstocks targeted in the pilots in other regions across Europe and more especially in BIOEAST region by identifying the key barriers and opportunities (task 2.1), analysing the potential that the valorisation of feedstock targeted in the three pilot cases has in other areas including BIOEAST region, providing a market overview focusing on the bio-application targeted and performing a study of consumer perception (Task 2.3) and developing the advisory board of farmers as a devoted workforce to assess the business models replicability in other regions (Task 2.4).

In this framework, Deliverable D2.2 represents the output of Task 2.2 and contains a description of the activities carried out to perform the resource assessment. The deliverable summarizes all the information collected from the pilots to evaluate the potential of the feedstocks targeted in the pilot regions and BIOEAST region to produce different bio-products such as the bioplastics, vegan protein, bioherbicides, etc. The deliverable describes the activities conducted to design the data collection process, to carry out the compilation and assessment of the data gathered, additional request of information when needed and performance of the potential assessment.

2. OBJECTIVES

Within this task, a resources assessment and feedstock mobilisation potential has been performed considering not only the 3 countries where the pilots are located but also BIOEAST region. In this regard, the analysis conducted targeted not only the feedstock addressed in the pilots (potatoes, rapeseed, sunflower, safflower, and cardoon), but also the main crops in these countries seeking to guarantee the future replication of the innovative and circular business models developed in BRILIAN.

Previous work carried out in tasks 5.1 and 3.1 has contributed to providing valuable inputs. In this sense, the description of the pilot provided in D5.1 and the evaluation framework described in D3.1 have been used as supporting documents to better understand the surrounding conditions and pathways targeted. In return, task 2.2 and the present deliverable have also contributed to compile information that will be used in task 3.4 for the LCA, LCC and LCSA and pilots' monitoring (Task 5.5).

The aim of this task is not to analyse the potential of the target crops (potato, rapeseed, sunflower), as these are traditional crops for which information is available from various sources. However, the key information on which this report focuses is the assessment of the generation potential of the by-products or side streams generated by the activity of target agro-industries, to assess in which countries the potential for replication of the business models developed in BRILIAN is most likely to be successful.

However, the potential of these by-products from the pilot cases in the eastern regions may not be as significant if these crops are not the main crops produced. For this reason, and although the business models of the pilot cases cannot be replicated directly, it is also important to know in these regions what is the potential for generating by-products or residues for the main crops, since BRILIAN can also provide valuable information for these agro-industries contributing to unlock the potential of these by-products through their valorisation. Key for success can also be extracted from the pilot cases for these regions to consider.

Therefore, this analysis will focus on the evaluation of the potential for agro-industries to obtain these by-products or side-streams, using average data obtained through the pilot cases which, although it does not allow a detailed analysis or obtaining accurate figures at local or regional level, it provides an estimate of the potential that is useful for defining areas (NUT2 level) with greater potential for replication.

The Nomenclature of territorial units for statistics (NUT) is a geographical nomenclature subdividing the economic territory of the European Union (EU) into regions at three different levels (NUTS 1, 2 and 3 respectively, moving from larger to smaller territorial units):

- NUTS1: Major socio-economic regions;
- NUTS2: Basic regions for the application of regional policies;
- NUTS3: Small regions for specific diagnoses.

3. STUDY AREA

The following chapter focuses on the description of the value chains of the pilot cases addressing the identification of the actors involved in each phase and their role and activities within the value chain, with a focus on the first steps of the value chain from the field to the biorefinery gate. More detailed information regarding the valorisation pathway at biorefinery level can be found in D5.1 and pilots' reports.

For the BIOEAST region, the description focuses on the main crops and most relevant agro-industries in the countries targeted.

3.1. Spanish pilot

UDAPA is a cooperative formed by farmers and business managers that was established in 1993 and is devoted to the handling and sale of fresh potatoes. Having farmers on board allows the company to be in direct contact with the product at the source. It is a second-degree cooperative which implies that it integrates different cooperatives: PROPACO S.COOP. (farmers), PROAGRAL S.COOP. (associated work for the management of the cooperative) and the cooperative bank LABORAL KUTXA S.COOP. This financial entity is a member of UDAPA with a small percentage of the share capital (0.76%), but it also participates in the Governing Council and contributes by providing a very enriching vision.

PATURPAT S.COOP. was created in 2016 by UDAPA as a way to meet new and developing consumer trends by creating food products that are easy to prepare. In PATURPAT the partners are UDAPA S.COOP., PROAGRAL S.COOP. and PROPACO S.COOP. with the following percentages of participation in the share capital respectively: 90%, 5%, 5% and 5%. Since its creation, PATURPAT has developed a range of ready-prepared products (

NUEVO ENVASE
udapa
FÁCIL
PATATA
PARA GUISOS Y TAPAS
COCIDA AL VAPOR
Tu plato en 5 minutos
PREPARADO
PARA ENSALADILLA
COCIDO AL VAPOR
patata-

Figure 1).

NUEVO ENVASE
udapa
FÁCIL
PATATA
PARA GUISOS Y TAPAS
COCIDA AL VAPOR
Tu plato en 5 minutos
PREPARADO
PARA ENSALADILLA
COCIDO AL VAPOR
patata-

Figure 1. Ready-prepared products commercialised by PATURPAT

The producer members (farmers) are suppliers of UDAPA and sign a contract with the supply cooperative under stipulated conditions. In this way, the members are aware of what the market demands and produce according to its needs. On the other hand, the management of the cooperative (General Management, Commercial, Financial, Maintenance, Production, Quality, R&D&I, Purchasing and Marketing) is carried out by PROAGRAL S.COOP. which is a workers' cooperative focusing on guaranteeing an efficient management and finding business opportunities and social success. Finally, the participation of LABORAL KUTXA provides the financial support and market vision necessary for the development of the project. A very important feature that differentiates the cooperative is that all the returns have been earmarked for new investments. For this reason, it has been possible to invest in new production plants and in the creation of PATURPAT for the launch of new potato-based convenience products as well as the investment in the starch extraction plant, looking to valorise the side streams produced in the process and to decrease the water consumption aligned with the sustainability and circularity objectives as well.

UDAPA and PATURPAT are located in Vitoria, Álava region. In this region UDAPA integrates around 14 potato growers and 4 seed potato growers. And there is a close relationship between them.

The combination of climatic conditions, soil composition, and a longstanding agricultural method in this region has resulted in the Álava's potato being acknowledged in the present day as a product of high quality. In this area, the potato is typically planted towards the end of April or the start of May and harvested from September to February. To avoid seasonality of the crop, supply areas have been extended to other territories with different sowing and harvesting seasons. In the overall, UDAPA commercialized around 79.000 tonnes of potato yearly. The main supply areas are Álava (320 hectares), Murcia (150 hectares), Sevilla (150 hectares), Castilla y León (100 hectares) and France (700 hectares). The varieties commercialized include: Monalisa, Lucinda, Colomba, Soprano, Agria, Amandine, etc.

UDAPA acquires annually around 79,000 tonnes of potatoes, 63.380 tonnes will be processed in their facility and around 57,042 tonnes will be finally commercialized. Out of the 79,000 tonnes, 15,620 tonnes will be processed in PATURPAT's facility where 11,184 tonnes will be commercialized as ready-prepared products.

The quantity of potatoes rejected by UDAPA is not sufficient to reach the capacity requested by PATURPAT. Therefore, PATURPAT also buys potatoes to complement the input flow provided by UDAPA.

Between June 2022 and May 2023, 15,620,617 kg were processed in PATURPAT coming from Álava (107 hectares), Murcia (50 hectares), Sevilla (50 hectares), Castilla y León (33 hectares) and France (233 hectares) (Figure 2).

Figure 2. Supply areas for UDAPA and PATURPAT

Regarding the average yield, there are significant variations among the supply areas. This yield can significantly affect the final quantity of starch produced and therefore the potential available for different bio-applications. On average 40-45 tonnes per hectare can be considered. Nevertheless, the average yield of each supply area is depicted in Table 1.

Table 1. Average potato yield

Supply area	Average yield (t/ha)
Álava	42 t/ha
Sevilla	45 t/ha
Castilla y León	50 t/ha
Murcia	45 t/ha
France	50 t/ha

Considering the information previously summarized regarding the structure of the cooperatives, it can be concluded that the target value chain in this pilot involves different actors. The first link in the chain corresponds to the farmer producing the raw material (potato) that is processed by UDAPA and PATURPAT. Initially, the first agro-industry, UDAPA, derives its side streams (rejected potatoes) to PATURPAT. Subsequently, a second agro-industry, PATURPAT, transforms the input materials (obtained from UDAPA and purchased from farmers) and valorizes the side streams of its process. PATURPAT utilizes the effluents/side streams from its process to initiate the valorization process, extracting starch that is in turn transformed into bioplastics and used in cosmetic applications (Figure 3).

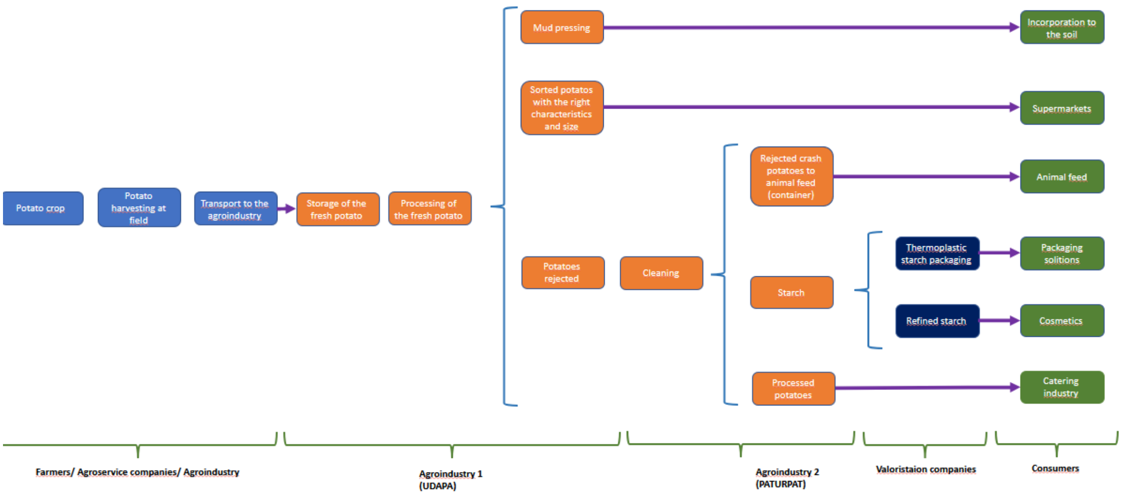

Figure 3. Value chain diagram and actors involved Spanish pilot

When the potatoes processed by PATURPAT do not come from the rejected materials from UDAPA, once received, they will go through a cleaning and a discarding process. The peeling and cutting process will follow. Water obtained from this last step is rich in starch and therefore will be one of the input flows that will be redirected to the extraction plant. Additionally, pieces obtained in the cutting process (

Figure 4) not complying with quality standards will represent the second input flow that will be redirected to the extraction plant.

Figure 4. Pieces of potato rejected in the production process

The rejected materials and water will go through crushing before entering the extraction plant. From the extraction plant three products will be obtained: starch, a process water with a lower COD and BOD and crashed potatoes pieces that will be used for animal feed (Figure 5).

Figure 5: Starch extraction plant

PATURPAT will therefore obtain a starch in a granular format that will be sold to potential plastic manufacturers or explored for cosmetic applications (Figure 6). The format and characteristics in terms of moisture content are key for the commercialization, therefore storage alternatives are being considered by the agro-industry to meet the potential consumers requirements.

Figure 6. Starch obtained

After receiving the starch, it goes through a drying process to obtain the starch as powder. Once the starch is dried, it is mashed and sifted through different sieves (Figure 7).

Figure 7. Starch undergoing drying process once received by AITIIP and TECNO

The starch is then introduced in the extruder together with xanthan gum, water, and glycerol to produce thermoplastic starch (TPS) (Figure 8). Water and glycerol will serve as plasticizer (facilitating the thermo-processing, by reducing the intermolecular forces and increasing the flexibility) while xanthan gum enhances the dispersion of the starch, improving the mechanical properties and storage stability of the final product.

Figure 8. Extrusion process

A filament is obtained, pelletized, dried, and stored. Since TPS has bad mechanical properties, it is combined with other materials to obtain blends to improve its performance. Therefore, TPS is introduced again in the extruder together with the selected materials depending on the end use:

- Shrink film: TPS+PLA (poly lactic acid) + PBAT (polybutylene adipate terephthalate)
- Mulch film: TPS+ biodegradable bioplastic

Once the pellet with the final formulation is obtained, it is introduced in the film extrusion machine to manufacture the end-product.

3.2. Danish pilot

The DLG Group, a cooperative owned by 25,000 Danish farmers and based in Fredericia, Denmark, is a prominent player in the European market across the sectors of Food, Energy, and Housing. While their origins lie in Denmark, their vision extends globally. Initially confined to operations within Denmark, the DLG Group has experienced substantial growth in the last two decades. Currently, it stands as a key player in Europe, with a focus on food, energy, and construction materials, boasting a presence in 18 different countries.

Figure 9. Rapeseed, Soybean and wheat crops

Within the Agribusiness domain, DLG encompasses the entire cycle of crop production, ranging from seed selection to the final harvest. This includes activities such as seed grain cultivation, fertilizer application, plant protection measures, and lime distribution for agricultural fields. Moreover, DLG is involved in the breeding, testing, and registration of various grain types, oilseed rape, peas, and maize for agricultural purposes (

Figure 9). DLG's primary operations involve the distribution of fertilizer and plant protection items, rather than manufacturing them internally.

The BRILIAN pilot case in Denmark focuses on the rapeseed feedstock for vegan proteins and bio-adhesive additive. As a crop, rapeseed is primarily grown for its oil. A big challenge to profitable rapeseed production is the limited use and market for the meal remaining after oil processing (rapeseed cake).

In Denmark, rapeseed is usually planted before end of August and harvested between July and August. In 2024 approximately 180.000 hectares were devoted to rapeseed cultivation in Denmark, resulting in a total production of 0.75 million tonnes. Of this amount, DLG expects to purchase 0.32 million tonnes. Of this amount, 0.21 million tonnes will be used by the DLG for its own production. The feedstock is supplied from different areas across the country (Figure 10).

Figure 10: Supply area covering the whole country

Regarding the average yield, there are significant variations between the different supply areas but in average a yield of 4.2 t/ha can be considered in Denmark.

The target value chain in this pilot involves different actors as depicted in Figure 11.

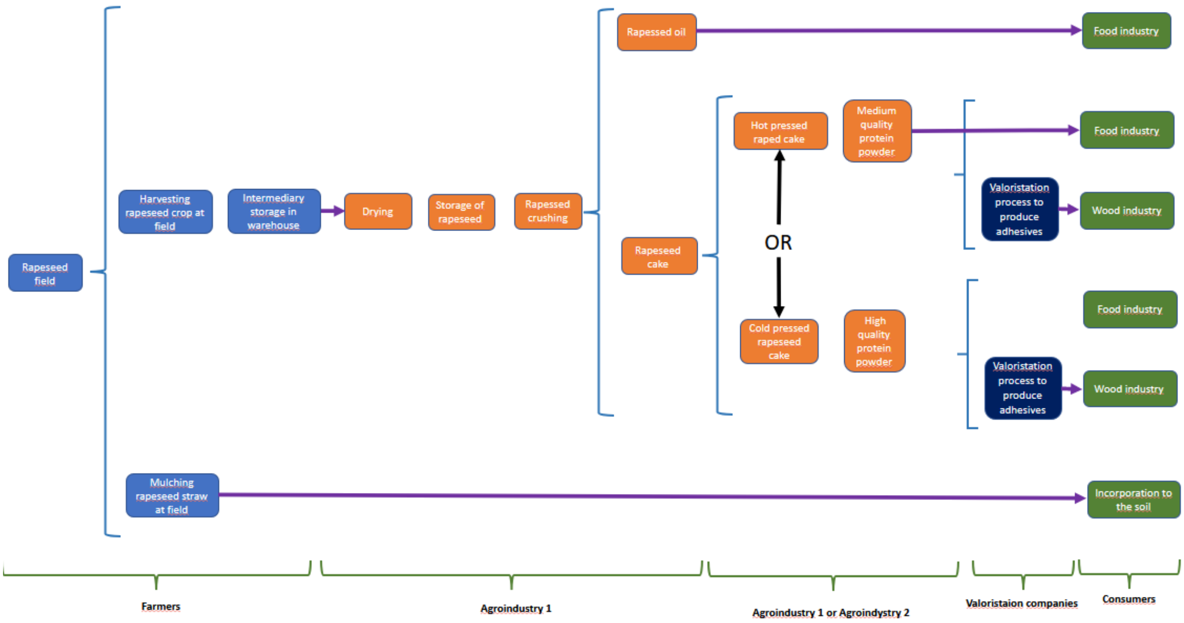

Figure 11. Value chain general diagram and actors involved Danish pilot

The first step of the value chain involves the farmers who produce the rapeseed and are also responsible for transporting the seeds to the warehouse with their own means. In some cases, the seeds will need to be transported from this initial warehouse to a larger warehouse. This transport is performed by a transport company (subcontracted). The transport from the warehouse to the agro-industry (DLG) will be carried out again by a subcontracted transport company. At the agro-industry (DLG), the seeds will be dried and crushed obtaining on the one hand the oil that will be commercialized by DLG and on the other the rapeseed cake that will be valorised for different bio-applications such as vegan protein and additives for bio-adhesives.

In the Danish pilot, the valorisation pathways tested are performed by DTI and CHIMAR, therefore the hot and cold rapeseed cakes produced by DLG will be transported to the corresponding facilities. In the long term, if the results obtained are promising, DLG will explore incorporating the facilities required to transform the rapeseed cake into vegan protein or bio-adhesive additive (Figure 12).

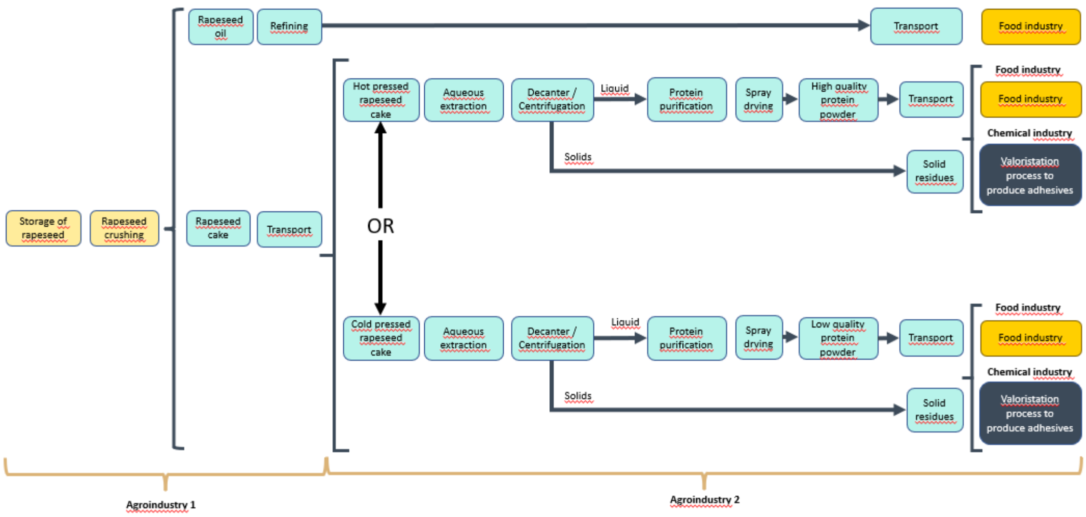

Figure 12. Valorisation pathways for the rapeseed cake

When rapeseed cake is processed to obtain vegan protein, the first step involves mixing the material with water. Depending on whether the material is hot pressed (HPR) or cold pressed (CPR) (Figure 13), an enzymatic hydrolysis can be performed to maximize the protein recovery.

Figure 13. Left: Cold pressed rapeseed cake (CPR). Right: Hot pressed rapeseed cake (HPR)

After the aqueous extractions, with or without enzymatic treatment, the stream is separated into solids and liquid, where the liquid stream contains the proteins and is the main product. The recovered solids are currently discarded, but they could be washed and used as animal feed or fiber source. Any remaining oil in the liquid fraction is removed, and the oil-free liquid is further processed to concentrate the extracted protein (Figure 14).

Figure 14. Food grade pilot plant facility at DTI.

The final protein-rich stream is dried and tested for different applications (Figure 15).

Figure 15. Final spray dried rapeseed protein powder.

Furthermore, this final product can be valorised in turn for other bio-applications such as the production of additives for bio-adhesives. This pathway is tested by CHIMAR in BRILIAN. In this case, the obtained concentrated protein powder is introduced into the phenol-formaldehyde resin during its synthesis, together with the other raw materials (phenol, formaldehyde, additives). The resin is cooked according to CHIMAR's technology and with a view presenting similar or better physicochemical properties than the conventional resin (Figure 16 and Figure 17).

Figure 16. Resin synthesis (left) and resin appearance (right)

Figure 17. Glue mixture preparation

CHIMAR's main goal in the BRILIAN project is to validate the use of the protein powder extracted from the rapeseed cake as a natural substitute for the fossil-based phenol and the main objective is to achieve the highest possible level of substitution (up to 50%, according to the indicated KPI at proposal stage). The evaluation of protein-enhanced resins is driven by the production of pilot scale wood composites (plywood type) and is assessed on the basis of whether the results of composites produced with these resins are comparable or better than those produced based on the conventional resin system (Figure 18).

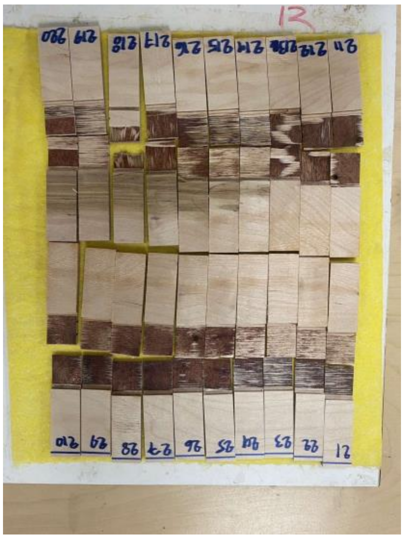

Figure 18. Board Shear strength test (left) and wood failure evaluation (right)

3.3. Italian pilot

The Italian Pilot is coordinated by NOVAMONT, an Italian company, international leader in the bioplastics sector and in the development of biochemicals from renewable resources. Nowadays the company encompasses four manufacturing facilities, three research hubs, sales branches in Germany, France, Spain, and the United States, along with a liaison office situated in Brussels. NOVAMONT is promoting the development of innovative value chains through the development of the Italian pilot in collaboration with Coldiretti (Italian farmers association). With one and a half million members, Coldiretti is the leading organisation of agricultural entrepreneurs at national and European level. It is widespread throughout the country: 20 regional federations, 95 interprovincial and provincial federations, 869 Area Offices and 3,576 municipal sections.

Within BRILIAN, the collaboration between NOVAMONT and Coldiretti disseminates the cultivation of low-input and dry resistant oil crops on marginal lands among farmers and promotes an innovative and sustainable agricultural model, compatible with local areas and resources. The main outputs of this model are the development of new income opportunities for farmers maximizing the efficiency of using the agro-feedstock obtained to produce the new added value bio-products.

Within the Italian Pilot, the farmers grow the oil crops to produce the agro-feedstocks while NOVAMONT provides its expertise for the biorefining process. The relationship between the involved stakeholders and the Italian Pilot is defined through an innovative contract system that rewards the positive externalities brought to land by farmers applying regenerative agriculture practices, ensuring them a minimum income. The establishment of collaborative supply chains among farmers and bioeconomy stakeholders at local level supports the development of a model of agricultural farming to produce agro-feedstocks for the bio-based industry. Not least, optimal mobilisation and integration of novel, under-used feedstock into new substrates for the bio-based industry is approached. The development of such model is further addressed by the activities of WP4.

The Italian Pilot promotes the adoption of regenerative agricultural practices through the cultivation of low-inputs oil crops: sunflower, safflower, and cardoon (Figure 19) supporting the recovery of abandoned and unproductive lands and obtaining the agro-feedstocks that the biorefineries will convert into added-value products, and specifically: oil seeds; vegetable oils, oil cake and lignocellulosic biomass.

Figure 19. Sunflower, safflower and cardoon crops

Cardoon (*Cynara cardunculus* var. altilis DC) is a perennial crop, well adapted to the Mediterranean climate, characterized by hot and dry summers. The establishment of the plantation is carried out from seeds, and it can take place from autumn to early spring. Cardoon needs low input management during the growing season. The harvest takes place in summer (from July to September) using a combine harvester coupled with a sunflower head, but it will also be possible to use a cereal header. The potential cardoon seeds average yield is 1.0 - 1.5 tons per hectare with an oil content between 18% and 28% (mechanical extraction). The by-product of the cardoon seed crushing is the oil cake with the production ratio between 72% to 82%. The potential yield of lignocellulosic biomass is from 10 to 15 tonnes per hectare.

Safflower (*Carthamus tinctorius* L.) is an annual oilseed crop adapted to be grown in arid and semiarid conditions. It is a low-input crop that tolerates water stress and can be grown in rotation with other crops. The sowing of seeds takes place from autumn (preferred in Mediterranean areas) to the end of winter with conventional seeder machines. The harvest can be carried out from July to September with combine harvester. The potential safflower seeds average yield is 2.0 tonnes per hectare with an oil yield (mechanical extraction) average of 30-36%. The by-product of the safflower seed crushing is the oil cake with the production ratio between 64% to 70%.

Sunflower (*Helianthus annuus* L.) is an oilseed crop cultivated throughout the world, and most of its products are commercialized in the industry, human and animals' food sectors. The sunflower crop is characterized as being grown in different climatic and soil conditions. The sowing is carried out with conventional seeder machines in spring period. Combine harvester with sunflower header is used to harvest the seed in the late summer. The potential sunflower seed average yield is 2.4 tonnes per hectare (depending on the area of cultivation) with an oil content of 30-36% (mechanical extraction). The protein fraction (oil cake) obtained after the crushing is 64-70%.

Regarding the average yield of the crops targeted, there are significant variations among different supply areas but in average the yield for each crop in central and southern Italy are depicted in Table 2.

Table 2. Italian pilot crops' average yields

Crop	Average yield (t/ha)
Sunflower	2.4 t/ha
Safflower	2.0 t/ha
Cardoon	1.1 t/ha seeds 12 t/ha straw

The target defined by the Grant Agreement for the Italian Pilot involves the cultivation of up to 59 hectares per year, from which the Italian pilot will obtain the biomass raw materials (biomass and seeds cake). The breakdown includes about 24 hectares of cardoon, 23 hectares of sunflower and 10 hectares of sunflower, allowing the recovery of up to 150 ha of marginal land at the end of the project.

Starting from the expertise developed by NOVAMONT in previous projects (FIRST2RUN), the cultivation of cardoon will be implemented on marginal lands (including dry land, or lands at risk abandonment or marginalization). As reported from D'Avino *et al*. (2020) the cultivation of cardoon represents an interesting option for farmers to valorise marginal land and contributes to increase soil organic carbon stock (SCOC).

In this sense, it is worth highlighting that low input crops can contribute to ensure a revenue for farmers, deriving in the first place from saving the costs related to soil improvers, fertilizers, plant protection products and land labour. At the same time, the adoption of an innovative contract system will grant a revenue from the purchase of the obtained productions.

In this context, cardoon and safflower will be used to recover soil carbon content, producing seeds that will be used to produce vegetable oils, oil cake and lignocellulosic biomass, which will be valorised in biorefineries to produce value added products.

The implementation of low-input crops such as cardoon and safflower will support the adoption of sustainable agriculture practices in marginal lands preserving soil health. Moreover, the implementation of resilient crops and innovative and versatile processes mitigates the adverse impact of external factors such as climatic events.

The target value chains in this pilot involve different actors in each case as depicted in Figure 20, Figure 21 and Figure 22.

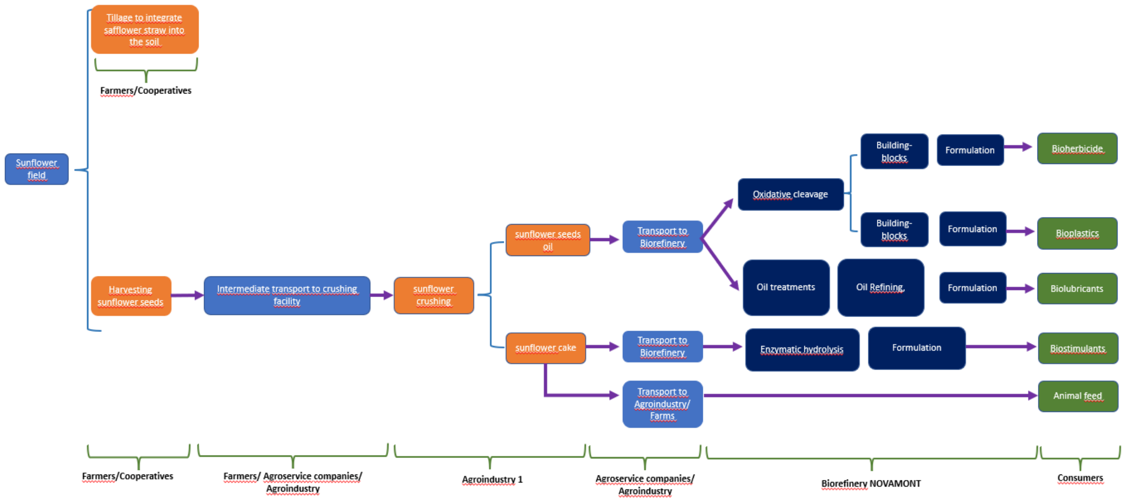

Figure 20. Sunflower value chain general diagram and actors involved Italian pilot

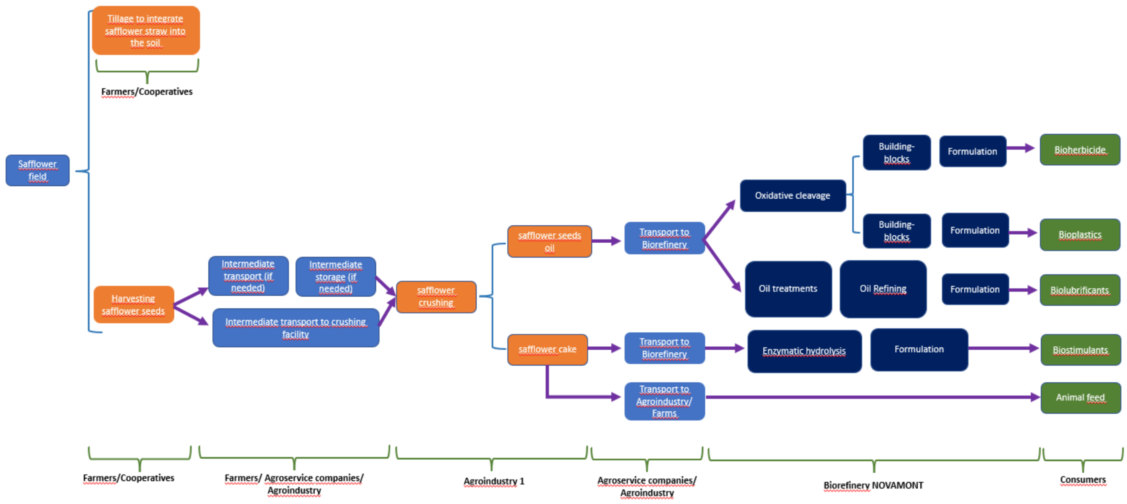

Figure 21. Safflower value chain general diagram and actors involved Italian pilot

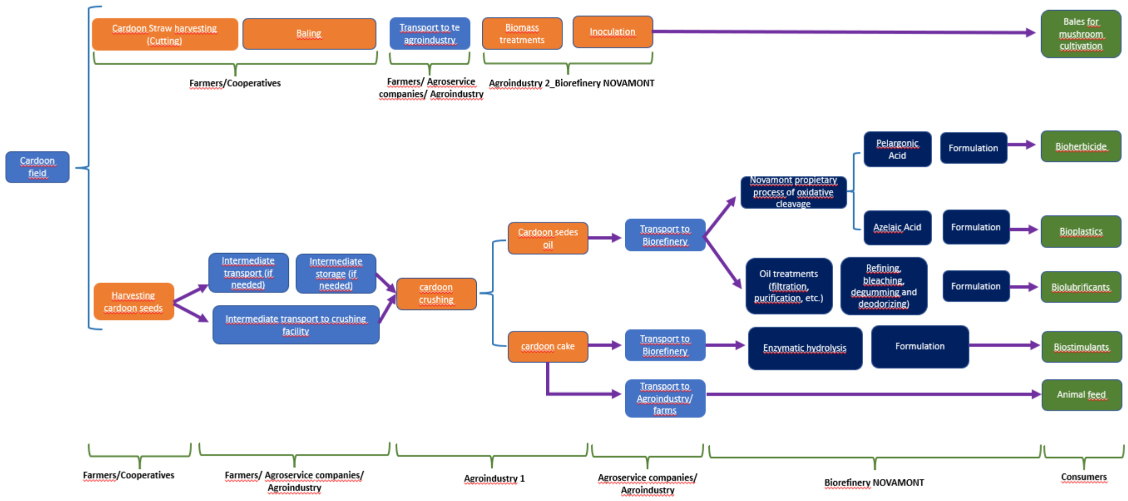

Figure 22. Cardoon value chain general diagram and actors involved Italian pilot

The farmers engaged in the pilot grow the oil crops to produce the agro-feedstocks, while NOVAMONT coordinates the agro-industry activities and provides its expertise for the biorefining process. Efficient logistic, sourcing and storage at the agro-industry stage is achieved thanks to the involvement of NOVAMONT's network and expertise. Moreover, several steps of the feedstock processing (e.g. seed crushing) are common for more than one value-chain, supporting the optimisation of feedstocks storage and logistics.

Value chains deployment in the pilot region implies different actions, coordinated by NOVAMONT in cooperation with the farmers involved in the Italian pilot (unless otherwise specified):

- Engagement of farmers and cooperatives for the cultivation of low inputs oil crops;
- Sharing the agricultural operational protocols with the involved farmers;
- Sowing the targeted oleaginous crops on marginal lands;
- Harvesting the produced agro-feedstocks;
- Storing the harvested agro-feedstocks;
- Crushing oil seeds;
- Collecting and storing vegetable oils, oil cake and lignocellulosic biomass;
- Transportation of vegetable feedstocks to the biorefineries.

At pilot level, the agro-feedstock (vegetable oils, oil cake and lignocellulosic biomass) will be transformed into six added-value products: animal feed; edible mushroom substrate; bio-lubricants; bioherbicides; bio-stimulants; bioplastics.

- Vegetable oils will be mechanically extracted from oleaginous seeds produced on marginal lands at the agro-industry and valorised at the biorefinery to obtain monomers for the formulation of novel bioplastics and bioherbicides. The process comprises of seed harvest and crushing to produce crude vegetable oils; the produced oil will then be transported to the biorefinery. Oils mechanically extracted from oleaginous seeds will be treated through Novamont's proprietary technologies to obtain monomers to produce biodegradable and compostable bioplastics for agricultural applications as well as bioherbicides that do not accumulate in soil.
- Oils mechanically extracted from oleaginous seeds produced on marginal lands, will be used for the formulation of novel bio-lubricants. The valorisation pathway of bio-lubricants requires an oil refining purification step followed by the formulation of bio-based biodegradable bio-lubricants.
- For the bio-stimulants application, the first stage of the agro-industry process involves seed harvest and crushing and oil cake collection. Once transported to the biorefinery, the oil cake will be treated through enzymatic hydrolysis to produce protein hydrolysates, to be used for the formulation of bio-based bio-stimulants, for application on food crops.
- Thanks to its high content of nutrients, the oil cake, by-product of oil seeds mechanical extraction, will be also used as animal feed. Upon the first agro-industrial stages of seed harvest and crushing, the valorisation pathway will

comprise of the following steps: oil cake collection (intermediate transport and storage will occur where needed), transport to external agro-industries devoted to animal feed production.

- Specialized producers of mushrooms bales involved in the Italian pilot as farmers will process this low value lignocellulosic biomass into ingredients to produce substrates useful for the cultivation of edible mushrooms. The valorisation pathway for mushrooms bales production comprises of a first step of lignocellulosic cardoon biomass harvest, which is then transported to the agro-industry. The biomass then undergoes specific treatment to produce mushrooms bales by the farmers involved in the pilot.

3.4. BIOEAST region

The establishment of BIOEAST initiative aimed at fostering a collective strategic approach to research and innovation in pursuit of sustainable bioeconomies within the Central and Eastern European (CEE) nations (Figure 23).

Figure 23. Focus BIOEAST region

Given the prevailing global complexities, the attainment of sustainability requires actions at the macro-regional scale. The BIOEAST Initiative has enabled the countries of Central and Eastern Europe (CEE) to establish a long-term goal for the year 2030, focused on the advancement of expertise and collaboration within circular bioeconomies. This strategic direction contributes to the promotion of inclusive economic growth and the generation of novel job opportunities, particularly within rural regions, while concurrently upholding or potentially reinforcing environmental sustainability. Circular and cooperative business models developed in BRILIAN can significantly contribute to addressing this commitment. Therefore, it is key to assess not only the potential to replicate the pilots' business models in these regions but also the potential to apply some lessons learned, ingredients of the recipe that the pilots have identified in value chains targeting other type of crops very relevant in these regions.

The countries participating in the BIOEAST Initiative are 11 in number: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. Although these countries present significant structural differences regarding their agricultural production model and the existing agro-industries, it is safe to say that there are common elements due to the climatic conditions. Wheat, maize, barley, and sugar beet consist of the biggest crops, while potato, rapeseed, and sunflower seed are also very common.

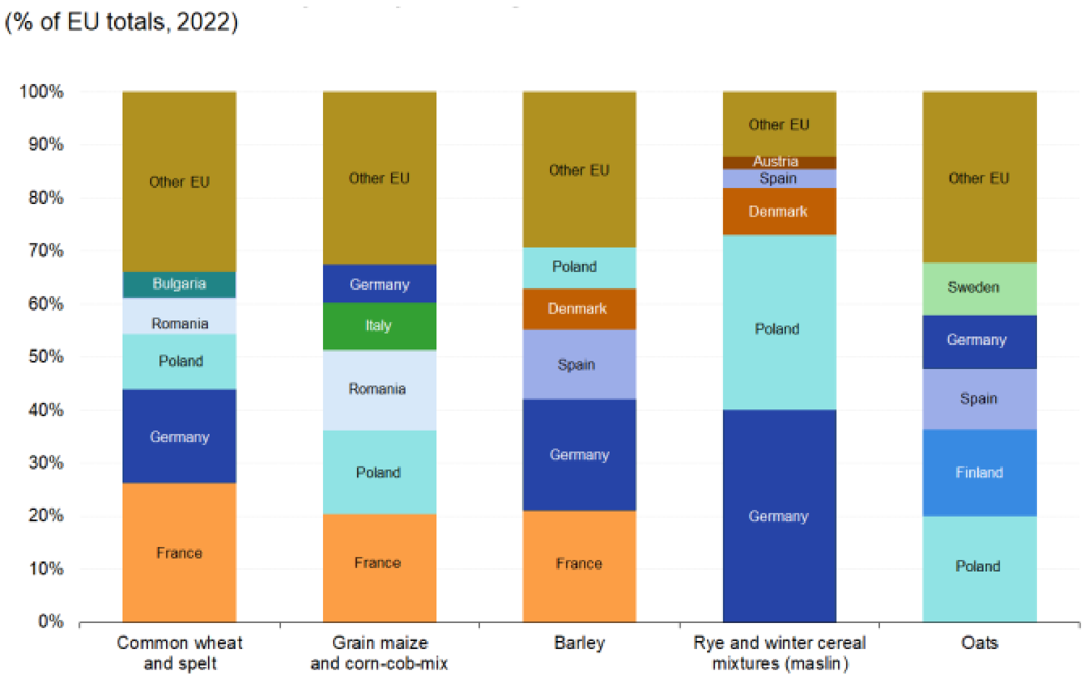

Figure 24. Production of cereals by main producing Member States 2022, (Source EUROSTAT)

The Figure 24 [7] depicts the biggest EU producers of cereals in percentage. Regarding wheat, the biggest production countries are Poland (third in production after France and Germany), Romania, Bulgaria [8]. On potatoes and sugar beet, Poland and the Czech Republic scored among the 10 biggest EU. More specifically, Poland got the third place and the Czech Republic landed on the seventh in 2022 as it appears on the figure above. The same crops are very common in the other BIOEAST countries as well although in varying quantities (Table 3).

Table 3. Crop production in eastern countries

Main crops' production in eastern countries			
Country	**Crop 1 (tonnes)**	**Crop 2 (tonnes)**	**Crop 3 (tonnes)**
Bulgaria	Wheat 6,447,770 t	Maize (corn) 2,554,370 t	Sunflower seed 2,140,590 t
Czechia	Green and silage maize 7,615,122 t	Wheat 5,188,687 t	Sugar beet 4,055,471 t
Croatia	Maize (corn) 1,641,890 t	Wheat 971,470 t	Green corn (maize) 765,700 t
Estonia	Wheat 854,120 t	Barley 488,820 t	Rape or colza seed 218,670 t
Hungary	Wheat 4,354,710 t	Maize (corn) 2,765,600 t	Barley 1,590,740 t
Latvia	Wheat 2,539,400 t	Rape or colza seed 359,100 t	Barley 281,600 t
Lithuania	Wheat 4,482,760 t	Rape or colza seed 900,950 t	Sugar beet 728,060 t
Poland	Sugar beet 14,154,120 t	Wheat 13,195,120 t	Maize (corn) 8,344,890 t
Romania	Wheat 8,684,240 t	Maize (corn) 8,037,130 t	Sunflower seed 2,106,570 t
Slovakia	Wheat 2,048,150 t	Sugar beet 1,096,750 t	Maize (corn) 683,700 t
Slovenia	Maize (corn) 277,820 t	Wheat 150,750 t	Barley

In alignment with the main crops mentioned above, there are relevant agro-industries. The cereal and milling industry that processes cereals into flours, groats and pellets, as well as cereal grains processed in other ways such as pasta, flakes or bran, bakery products etc. is rather strong in the biggest cereal production countries (Poland, Romania, Bulgaria). The biggest portion of the cereal production, however, is destined for livestock feed production for the farming sector. Therefore, animal production, where Romania exceeds, and related food processing including dairy products, confectionery products and meat products is also flourishing and exported with intensity depending on each country's circumstances. The food and beverage production sector is a big contributor to the BIOEAST countries' economies. The brewery sector is also flourishing in many BIOEAST countries like Poland and the Czech Republic.

In the BIOEAST macro-region overall, there is a big number of small and medium sized enterprises and farms and only a few big companies, who are also accounting for the biggest production quantities [9]. While countries like Poland and Romania are gradually investing in precision agriculture methods to increase yields, agricultural land use is rather fragmented. This applies both for the agricultural and the industries sector. Other industries that are encountered in the BIOEAST region are the chemicals and fertilizer production industries as one of the key sectors of the entire Polish industry, while it is also present in other countries like Czech Republic.

In general, the BIOEAST region presents excellent potential for novel agricultural applications with tech transfer being also among the priorities for the macro-regional development. It is notable, however, that besides the high agricultural performance of the macro-region establishing it as a key EU producer, during the past few years, performance has marked a decrease. This reduction in yields is attributed to environmental and climate change factors. Therefore, there is one more significant reason to identify and apply alternative and sustainable production methods and value streams to secure the abundance and efficiency of resources, especially under the currently challenging geopolitical circumstances.

4. METHODOLOGY

4.1. Resource assessment

Assessing biomass is crucial to support the evaluation considering the development potential to deploy bio-based value chains in different areas. Additionally, utilizing biomass effectively can significantly contribute to reducing environmental burdens, and promote sustainable living while contributing to forge robust rural communities and diversifying the incomes of primary producers. Furthermore, biomass plays a key role in future bioeconomy strategies at European and national level in line with the sustainability and climate change mitigation objectives.

Due to the complex nature of biomass production and use, it is quite challenging to estimate its potential. Biomass potential assessment of crops has deeply been assessed for different types of biomasses. However, the present biomass assessment focuses on the side-streams potential assessment of the pilot cases, to support the identification of most suitable regions to replicate the business model developed based on the pilots. It is worth highlighting that there is also considerable uncertainty surrounding estimates used to calculate biomass potentials. The estimates used in the present assessment are based on the pilots participating in BRILIAN and therefore provide only estimates to evaluate the potential at NUT 2 level at European level, but considering the aim of the analysis, the outcomes obtained correspond to a sufficiently accurate approximation to identify regions (NUT 2) with the highest replication potential.

To perform the biomass assessment, the following steps have been accomplished:

- Definition of the input data needed.
- Elaborating a template for the data collection.
- Meeting with the partners to explain the data collection process.
- Launching the data collection process with the pilot cases.
- Assessment of the data collected.
- Searching for additional and complementary information such as production ratios from papers or statistical sources consulted (EUROSTAT, statistical yearbooks, etc.) carry out the assessment.
- Sensitivity assessment: assuming the ratios considered are average values, a sensitivity assessment has been performed to evaluate how the considerations assumed can affect.

As mentioned in the previous chapter, the assessment was also performed targeting the BIOEAST region. The main aim in this case was to evaluate the potential of the feedstocks targeted in the pilot cases but also the most relevant crops in these regions. The steps followed in this case included:

- Discussing the most appropriate considerations to assess the potential in the BIOEAST region considering the replication potential.
- Data collection requested to BIOEAST Hub CZ.
- Assessment of the data collected and identification of regions where the crops targeted in the pilots are relevant, as well as most important crops in these regions.
- Literature review looking for by-products' ratios (estimate potential side-streams production for the crops assessed).
- Sensitivity assessment: assuming the ratios considered are average values, a sensitivity assessment has been performed to evaluate how the considerations assumed can affect.

5. BIOMASS ASSESSMENT

When seeking to boost promotion of bio-based value chains, one of the critical aspects to consider is to accurately estimate the available biomass that can be used as raw material for different bio-applications. In the pilot cases targeted in BRILIAN, that means starch for bioplastics and cosmetic application in Spain, oleaginous crops feedstocks for biolubricants, biostimulants, bioherbicides, animal feed, bioplastics and substrate for edible mushroom production in Italy; and vegan protein and additives for bio-adhesives in Denmark. This deliverable aims to summarize the information collected and analysed for the biomass assessment for each one of the pilots of the project. Additionally, the potential quantity of by-products or side streams obtained from the most relevant crops in these regions will be also evaluated, considering that potential bio-based value chains valorising these side-streams will also find key for success and valuable information to deploy them, based on the outcomes produced by BRILIAN.

Due to the large variations when quantifying the potential biomass available for a certain bio-application, the biomass assessment is key and can strongly affect the technical, environmental, and economic suitability and sustainability of the bio-based value chain to promote. Challenges arose on the assessment of the biomass potential when determining the availability of the resource in the short, mid and long term or the data availability to perform the evaluation. Furthermore, the uncertainty inherent to some of the input data due to the changing consumers preferences affecting the final use in the short and mid-term, technology improvements affecting the transformation yield, logistic improvements, climate change effect on the biomass produced (crop yield), etc. leads to the needs of establishing considerations with a certain inherent degree of uncertainty.

The following section will summarize the information and assessment performed for each one of the raw materials targeted for the pilots and the eastern countries.

The assessment has been performed considering NUT 2 level and the crop information in terms of production, yields, areas devoted to each crop has been consulted in EUROSTAT database [10]. The production of the crops targeted, except for the safflower, has been extracted for EUROSTAT database. For this aim, the average production of the last 5 years (2015 to 2021 both included, when available) has been used seeking to consider the fluctuation occurring due to changes in the weather conditions during the cropping season. The information needed in terms of production was not available for all crops targeted, therefore additional databases such as FAO database [11] were also consulted for the safflower. For the safflower, the information consulted only depicted values at country level therefore an assessment at country level and not regional level has been performed considering the information available.

The case of the cardoon requires a different approach since the cultivation system tested in the Italian pilot for this crop considers the cultivation in abandoned and marginal lands. The potential replication in this case requires considering not only crop, field and productive aspects, but also regulations in terms of availability of this type of areas to produce crops such as cardoon, targeting the production of added value products for different bio-applications. In this case, the base information needed could not be found in EUROSTAT or FAO databases although some projects have addressed this topic such as project MAGIC12] (Figure 25) or MAIL project [13] (Figure 26), papers and reports [14, 15, 16 and 17].

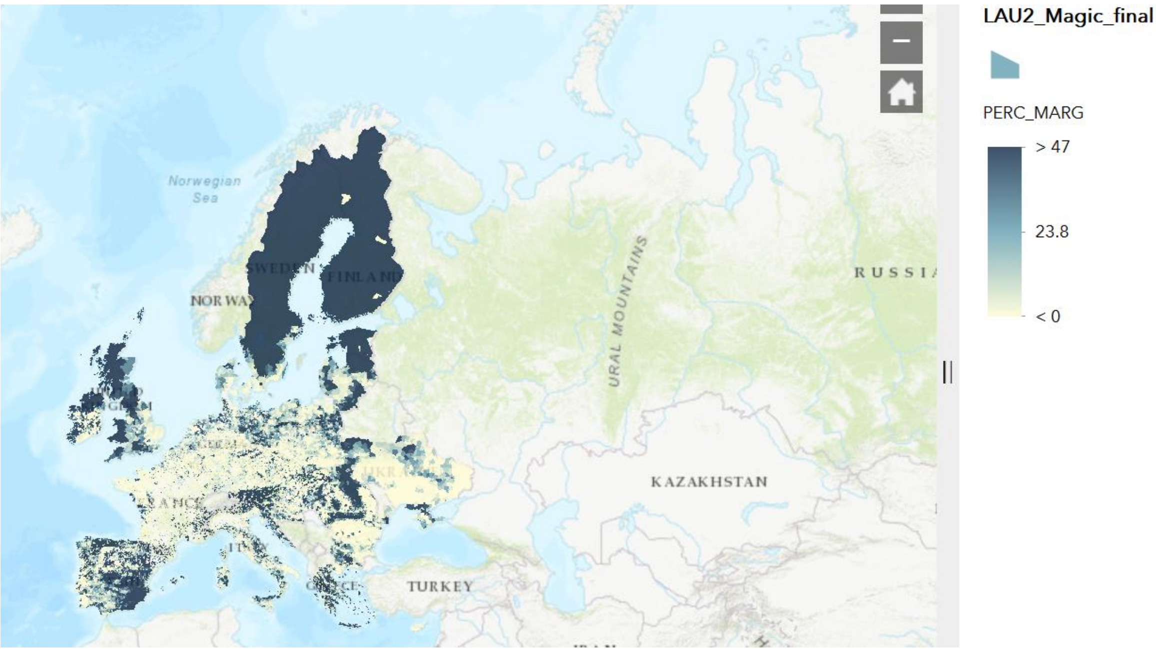

Figure 25. Share marginal land, project MAGIC

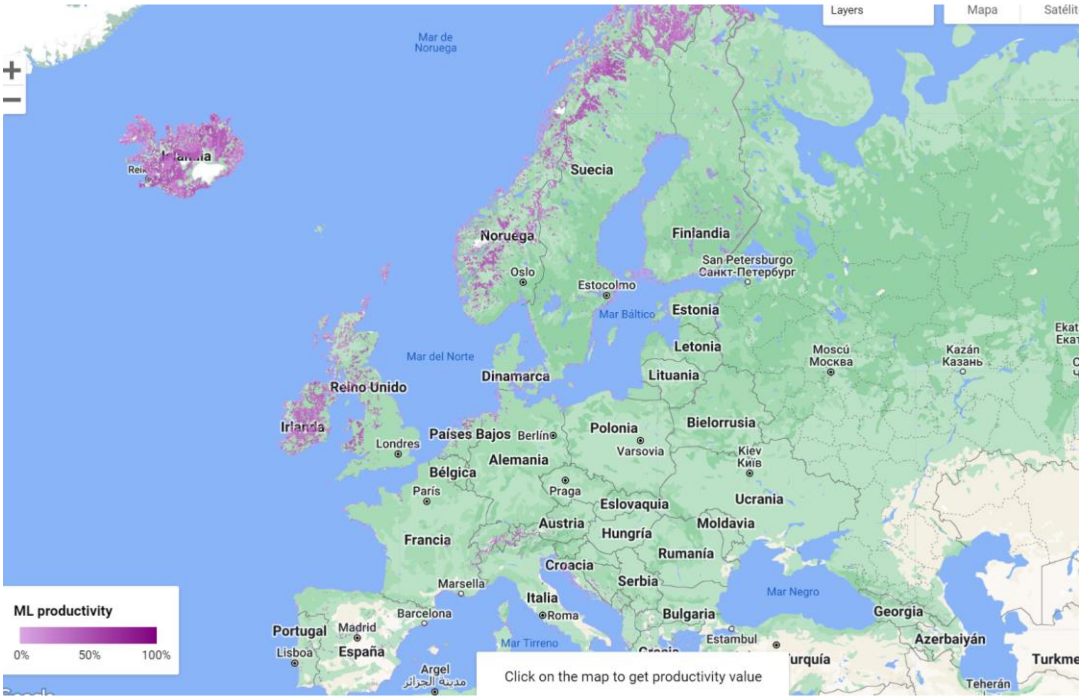

Figure 26: Marginal land productivity, project MAIL

Considering the lack of official data sources available to abandoned and marginal lands, the regulations affecting its exploitability at European but also national and even local level and the social aspects that can also play a key role, it was concluded that the assessment in this case will need to be considered at local level and requires of the outcomes achieved at the end of the Italian pilot for the cardoon to estimate the potential replication. Therefore, the assessment regarding the feedstock targeted in the Italian pilot will focus on the sunflower and the safflower.

5.1. Starch from potato and water from the process, Spanish pilot

The information collected for the Spanish pilot by PATURPAT focused on the definition of the losses occurred from the fields where the potatoes are collected, during the transportation and storage until entering the process.

Additionally, monitoring the moisture content of the raw material at various stages has been crucial.

Furthermore, determining transformation ratios from the moment that the potatoes enter the process in PATURPAT, to the amount of material rejected from the process that will be conducted to the starch extraction plant and the yield of the plant, have been key to obtain the potential amount of starch expected that can be valorised for added-value applications.

The key considerations assumed have been summarized in Table 4.

Table 4. Consideration for the Spanish pilot case

Spanish pilot case considerations		
Parameter	**Value**	**Comment**
Crop dry matter content	16.5%	15-18 % depending on the weather conditions
Losses during harvesting	1%	Handling and transport
Share of raw material commercialized in the fresh market (raw potato packaged)	69%	
Share of raw material rejected in the fresh market	2%	
Share of raw material commercialized in the potato ready prepared market	31%	
Share of raw material rejected in the potato processed market (ready prepared products such as French fries)	26%	
Starch yield	1%	

Based on the information extracted from the Spanish pilot case and the regional and crop data consulted in EUROSTAT database, the starch potential from agro-industries processing potatoes (not to be consumed fresh) is depicted in Figure 27.

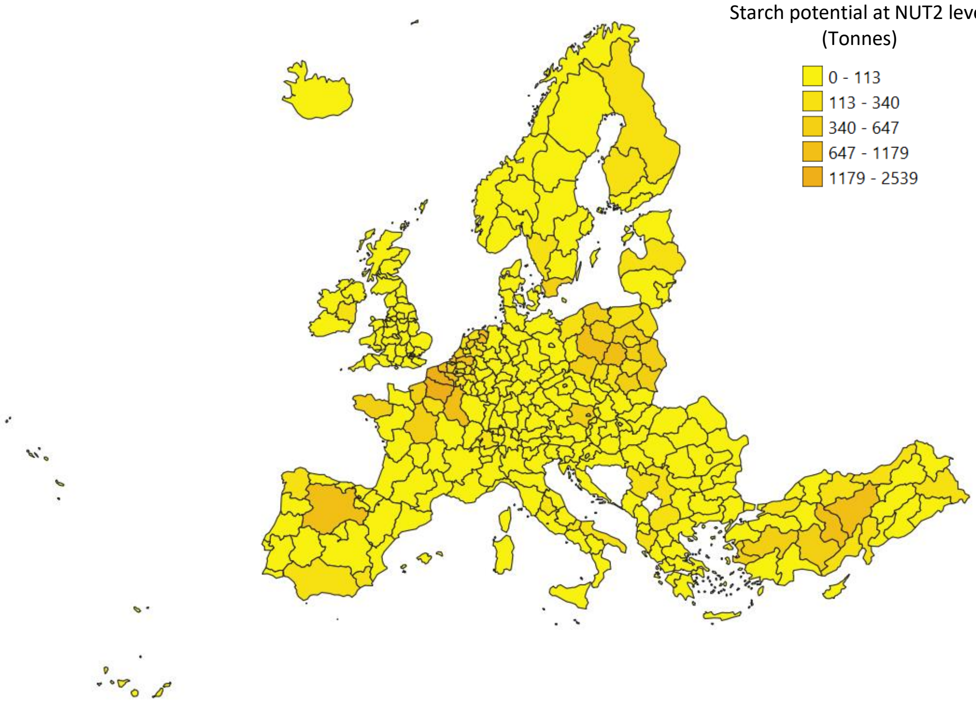

Figure 27. Starch potential

The regions with the highest potential are located in Spain, France, Belgium, Germany, Poland, Sweden, Netherlands and Romania. Considering the share of rejected material that could be valorised to extract starch, countries in which potatoes are processed to ready prepared products could have a better chance to replicate the business model developed in the BRILIAN Spanish pilot case. Belgium is a good example since big companies focusing on French fries' production facilities can be found.

A sensitivity analysis was carried out to assess the impact on the potential at NUT 2 level resulting from the main variables fluctuation (Table 5). In the first sensitivity analysis, the impact was analysed if potato production decreased by 5%, which could be a consequence of temperatures or rainfall variance affecting the crop yield. The second variable studied was the change in the final customer's consumption preferences in such a way that the percentage of potato destined for fresh consumption falls to 50%, a scenario which implies a very significant variation on the consumers' pattern. If the trend towards consumption of prepared products was consolidated, it would most likely not be reflected in a very short period and would be progressively changing; this consideration allows to evaluate what the impact of the change in consumption preferences would imply in terms of side stream valorisation for starch obtaining. The third variable focuses on technological improvements that could lead to a starch extraction yield of 1.5%.

Table 5. Sensitivity analysis starch potential

Parameter	Potential starch (tonnes)
Base scenario	37,499.9
Sensitivity analysis 1	35,624.9
Sensitivity analysis 2	55,614.3
Sensitivity analysis 3	56,249.8

The main challenges addressed when valorising potato side-stream include enhancing sustainability of the valorisation pathways, managing industrial side-streams in an efficient way, lowering the economic instability due to the crop production fluctuations yearly and optimization of storage to maintain the properties requested to commercialize the new product, among others [18,19,20,21,22,23].

Regarding the main constraints faced, for the pilot case of the project, two challenges faced relate to the possibility of integrating the infrastructure (piping, connections, and extraction plant) into the agro-industry's processing plant, which in many cases involves a redesign of the spaces to make room for this infrastructure while guaranteeing the correct operation of the line and the new installations. Furthermore, the installation of the infrastructures necessary for the valorisation of the by-product involves an investment and thus a risk associated with the development of a new line of business complementary to the traditional activity to market a product destined to very different markets from the food market.

The replicability of this value chain will be more suitable in regions where agro-industries devoted to potato products commercialization can be identified, in which the percentage of rejection is higher, the installation of recovery equipment and the necessary infrastructure (extraction plant, etc.) is viable and the market potential of the bio-product generated (starch) is significant. Considering the low percentage of losses associated with the logistics of the resource, actions aimed at reducing this percentage or valorising them around the origin area have less projection.

5.2. Oil extracted from rapeseed seeds, Danish pilot

The information collected for the Danish pilot by DLG focused on the definition of the losses occurred from the fields where the rapeseed is collected, during the transportation (one or 2 warehouse intermediate storage), the storage itself and until entering the process. In this case, an additional transport is needed to transport the raw material to be valorised (rapeseed cake) to DTI and in turn to CHIMAR but, based on the results of the project, the final aim is for DLG to integrate additional facilities to be able to process itself the rapeseed cake.

Moisture content of the raw material has also been monitored at different stages from the field to the agro-industry. Additionally, and the most important, determining transformation ratios to convert the rapeseed into rapeseed cake has been key to obtain the potential amount of rapeseed cake expected that can be valorised for added-value applications as previously mentioned.

The key considerations assumed have been summarized in Table 6.

Table 6. Consideration for the Danish pilot case

Danish pilot case considerations		
Parameter	**Value**	**Comment**
Crop moisture content	12.5%	8-13 % depending on the weather conditions
Losses during harvesting	1%	Handling and transport
Moisture content after drying	7.5%	7-8 %
Rapeseed cake ration	580 kg rapeseed cake/t rapeseed seeds	

Based on the information extracted from the partners participating in the Danish pilot, (DLG, DTI and CHIMAR) and the regional and crop data consulted in EUROSTAT database the rapeseed cake potential from agro-industries processing rapeseed is depicted in Figure 28.

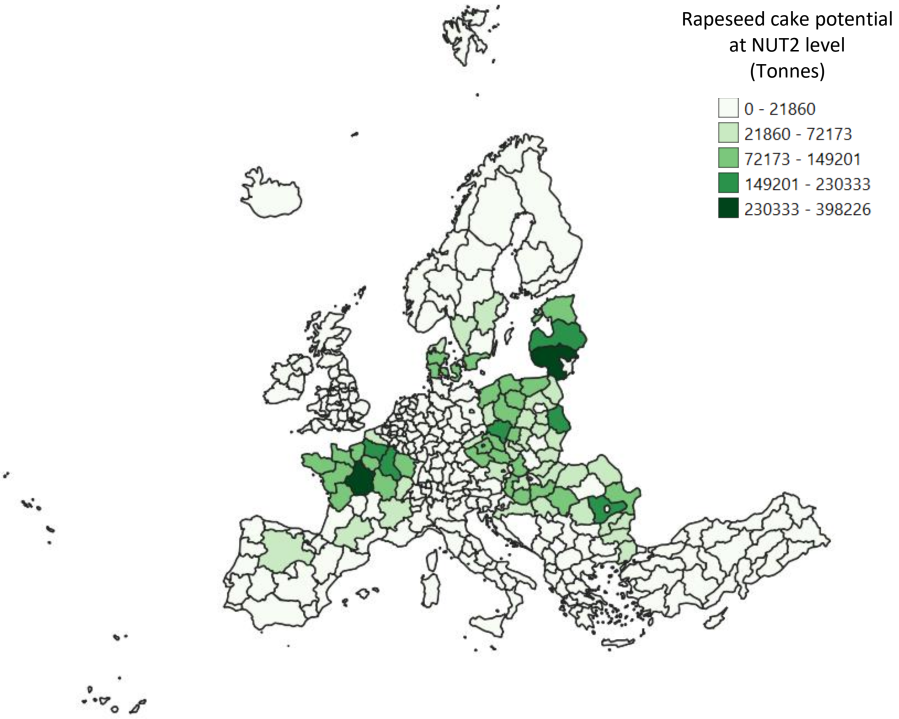

Figure 28. Rapeseed cake potential

The regions with the highest potential are located mainly in France, Denmark, Sweden, central regions in Spain and eastern countries such as Lithuania, Latvia, Estonia, Poland, Czechia, Slovakia, Hungary, Romania, Bulgaria.

A sensitivity analysis was carried out to assess the impact on the rapeseed potential due to fluctuations of the climate conditions affecting the yield of the crop. For this aim, an increase and decrease of the crop yield of 5% were tested when combined with additional losses (losses increased up to 2%) that might occur when weather conditions make harvesting difficult. These variables impact directly on the rapeseed potential depicted in Table 7.

Table 7. Sensitivity analysis rapeseed cake potential

Parameter	Potential rapeseed cake(tonnes)
Base scenario	7,121,340
Sensitivity analysis 1 (yield decrease, losses increase)	6,013,580
Sensitivity analysis 2 (yield increase, losses increase)	6,646,580

Challenges encountered in the valorization of rapeseed cake encompass for instance the optimization of protein extraction techniques, the efficient management of the substantial volume of waste generated, the mitigation of antinutrients such as phenolics to augment protein digestibility, and the preservation of the quality and yield of the final product during protein extraction processes [24,25,26, 27,28].

More concretely, aspects to tackle in the Danish pilot case of the project include the logistic of the raw material (rapeseed cake storage and handling), which will most likely require not only a significant space but also the implementation of additional handling procedures, the investment required to install the valorisation facilities, designing a commercialization strategy for the new product different from the traditional (rapeseed oil) and the most pressing issue, the upscaling of the technology that has been tested at pilot scale.

The replicability of this value chain will be more suitable in those regions where significant potential associated with rapeseed oil extraction activity has been identified, the model has significant potential, however, as in the pilot case, the scale-up of the valorisation technology and the investment required will be key aspects to be considered.

5.3. Oil and biomass from cardoon, sunflower and safflower, Italian pilot

The information collected for the Italian pilot by NOVAMONT focused on the definition of the losses occurred from the fields where the sunflower, safflower and cardoon are collected, during the transportation, the storage and until entering the seed-crushing process. The cake obtained from this process is then transported to the biorefinery and stored which might imply additional losses to consider by NOVAMONT.

Moisture content of the raw material has also been monitored at different stages from the field to the agro-industry.

Additionally, and the most important, effort were allocated to determine the transformation ratios to convert the seed to the cake that can be valorised for added-value applications as previously mentioned.

The key considerations assumed have been summarized in Table 8,

Table 9 and Table 10.

Table 8. Consideration for the cardoon pilot case

Italian cardoon case considerations		
Parameter	**Value**	**Comment**
Moisture content	10%	8-12% depending on the weather conditions
Losses during harvesting	3%	Handling and transport
Cardoon cake ratio	770 kg cardoon cake/t cardoon seeds	

Table 9. Consideration for the sunflower pilot case

Italian sunflower case considerations		
Parameter	**Value**	**Comment**
Moisture content	12.5%	10-15% depending on the weather conditions
Losses during harvesting	1.1%	Handling and transport
Sunflower cake ratio	670 kg sunflower cake/t sunflower seeds	

Table 10. Consideration for the safflower pilot case

Italian safflower case considerations		
Parameter	**Value**	**Comment**
Moisture content	10%	8-12% depending on the weather conditions
Losses during harvesting	1%	Handling and transport
Safflower cake ratio	670 kg safflower cake/t safflower seeds	

Based on the information extracted from the questionnaires provided by NOVAMONT in cooperation with the farmers and farmers' association collaborating in the Italian Pilot and the crop data consulted in EUROSTAT database the sunflower, safflower and cardoon cake potentials from agro-industries processing these crops are depicted in Figure 29 and Figure 30.

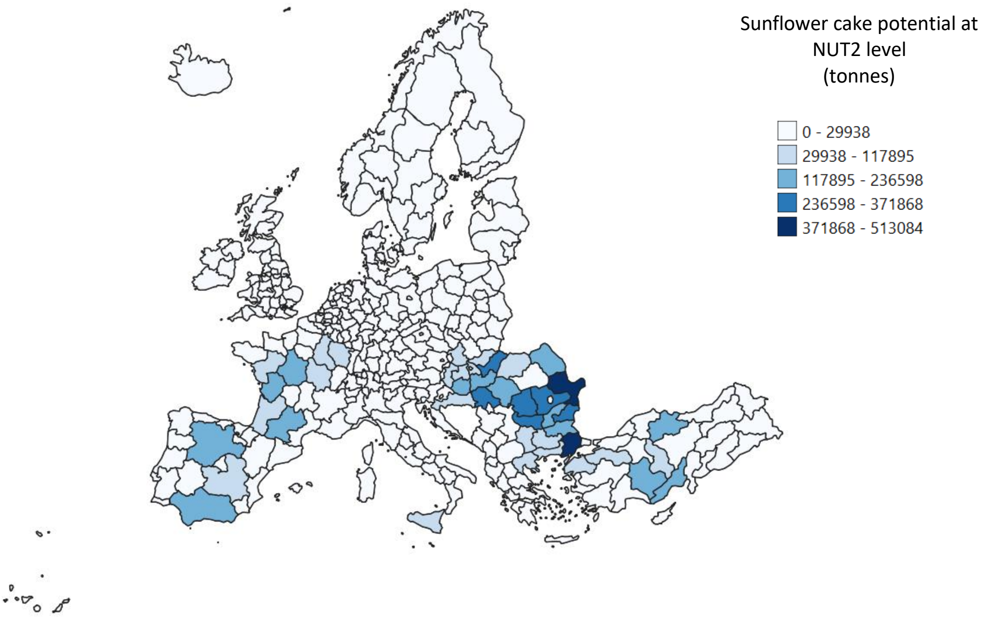

Figure 29. Sunflower cake potential

The regions with the highest potential are located mainly in Spain, France and eastern countries such as Slovakia, Hungary, Romania, Bulgaria (Figure 29).

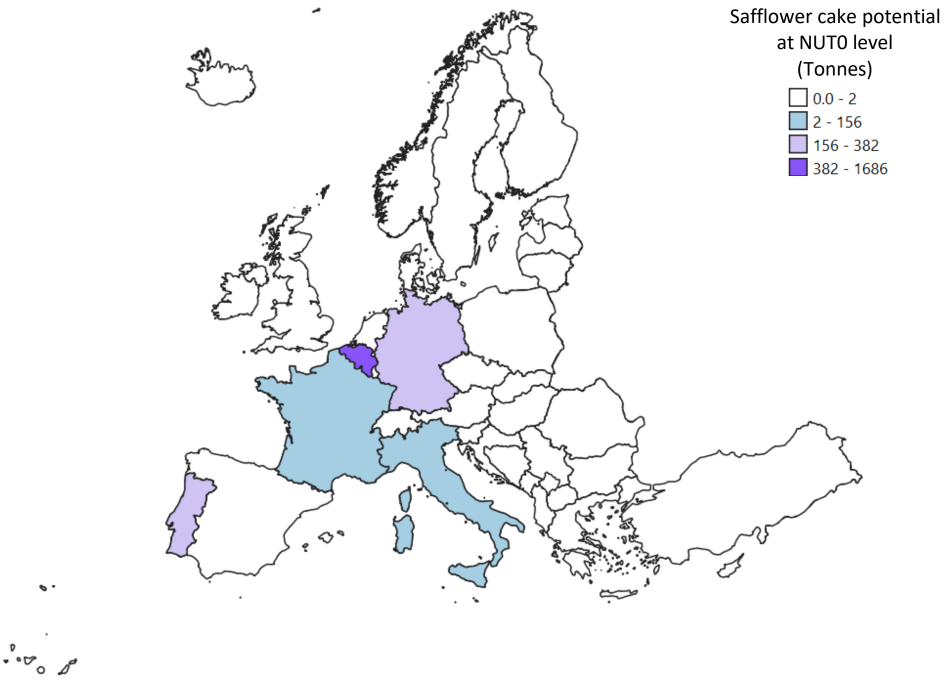

Figure 30. Safflower cake potential

For the safflower assessment the FAO statistic database was consulted. Input data for safflower was found for Belgium, Denmark, France, Italy, Netherlands, Portugal and Spain. The safflower cake potential has been evaluated in these countries based on the statistics available. In any case, the most updated information was from 2020, therefore new fields could have switched to safflower production in the last years. Updates on the reference statistics could contribute to assess more in detail the current situation. In any case, the mentioned countries show a significant potential to valorise the safflower cake for different bio-applications, such as the Italian pilot case in BRILIAN.

A sensitivity analysis was carried out to assess the impact on the sunflower and safflower potential due to fluctuation on the climate conditions, affecting the yield of the crop. For this aim, a 5% increase and decrease of the crop yield were tested when combined with additional losses (losses increased up to 2%) that might occur when weather conditions make it difficult to perform the harvesting. These variables directly affect the cake potential depicted in Table 11.

Table 11. Sensitivity analysis sunflower and safflower cake potential

Parameter	Potential sunflower and safflower cake (tonnes)
Base scenario sunflower	7,577,710
Sensitivity analysis 1 sunflower	5,759,060
Sensitivity analysis 2 sunflower	6,365,280
Base scenario safflower	4382,08
Sensitivity analysis 1 safflower	3330,38
Sensitivity analysis 2 safflower	3680,95

Challenges in valorizing sunflower/safflower and cardoon cake may include: overcoming processing hurdles, optimizing nutritional extraction when addressing feed applications, achieving sustainable value chain deployment to optimize environmental impact, improving logistic and pretreatments to reduce volume and specific weight of cakes, modifying biopolymer macrostructures during extraction and determining composition and characterizing components for plastic material development [29,30,31].

The presence of intermediate facilities to carry out the first steps of the valorisation pathways is crucial to optimize the value chain from the economic, environmental but also social and technology point of view. Therefore, the Italian Pilot promotes feedstock transformation at local level seeking to optimize the logistic of the materials and to reduce the costs.

The optimization of the logistic is relevant to achieve a successful deployment of the value chain, and the collaboration agreement among the actors of the value chain plays a fundamental role in this case. To build an efficient and replicable model, all these aspects are considered in the development of the Pilot's activities. The replicability of this valorisation scheme, based on the by-product obtained from seed crushing and pressing, is more feasible in those areas where farmers have grouped together in cooperatives or associations to reach a minimum quantity of product that makes the installation of processing equipment profitable. Nevertheless, the current use of the seed cake should also be considered, areas where this side stream is not currently used are more attractive to replicate the model. Additionally, bio-based value chains in which the generated added products (biostimulants, bioherbicides, bioplastics for mulching or packaging, etc.) can be used by the primary producers involved as suppliers (first step of this value chain) would result in even more sustainable circular value chains, contributing to the environmental and social performance. This scheme could be quite interesting for other regions to replicate the model. Additionally, considering that cardoon and safflower are aimed to be cultivated in marginal lands, the regulations addressing the crops that can be cultivated in areas classified as marginal or abandoned should also be checked, as there might be some differences among the regions that will be worth considering.

5.4. Crops targeted in the BIOEAST region

The information collected by BIOEAST focused on the definition of the most relevant crops and the production figures for the feedstock targeted in the pilot regions. On the one hand, the business model developed for the target feedstock by the pilots could be exported to those regions where these crops achieve a relevant production (although adjustments will always be needed to address regional specificities). On the other hand, keys for success and roadmap's structure can be adapted and replicated by biobased value chains targeting different feedstocks (for instance straw from wheat and barley or corn starch from maize). According to the information compiled and depicted in the previous chapter (3.4) the selected crops are wheat, maize and barley.

In this case, considering that the information required for the assessment cannot be collected through the pilot cases, a literature review has been performed mainly focusing on establishing the conversion ratio for the obtaining of the side streams and by-products. Different factors affecting the RPR (residue to product ratio) are nutrient supply, application of chemical, growth regulators and moisture content. Nevertheless, the RPR can be used for the assessment of biomass suitability in the biorefinery [32]. The literature review outcomes are depicted in (Table 12, Table 13 and Table 14).

Table 12. Wheat residue to product ratio

RPR Wheat		
RPR	**Source**	**Comments**
0.3-1.5	Ramesh *et al.* (2021)	
1.3	Ericsson and Nilsson (2006)	
1.2	Johnson *et al.* (2006)	
1.34	Kadam and McMillan (2003)	
1.75	Koopmans and Koppejan (1997)	
0.6	Koukios (1998)	
1	Panoutsou and Labalette (2006)	
RPR = -0.3629*ln(Y)+1.6057	Scarlat *et al.*, 2010	"Y" refers to the crop production ratio (t/ha)
RPR = 2.186*exp(-0.127*Y)	Bentsen *et al.*, 2014	"Y" refers to the crop production ratio (t/ha)
RPR=0.769−0.129*ATAN((Y−6.7)/1.5)	Edwards RAH, Šúri M, Huld TA, Dallemand JF. GIS-based assessment of cereal straw energy resource in the European Union. In: Proceedings 14th Eur. biomass conference exhib. ETA-renewable energies WIP-renewable energies; 2005	"Y" refers to the crop production ratio (t/ha)

Table 13. Barley residue to product ratio

RPR Barley		
RPR	**Source**	**Comments**
1.3	Ramesh *et al.* (2019)	
1.3	Ericsson and Nilsson (2006)	
1.5	Graham *et al.* (2007)	
1	Johnson *et al.* (2006)	

1.75	Koopmans and Koppejan (1997)	
1	Nelson (2002)	
1.24	Panoutsou and Labalette (2006)	
1.5-1.8	Patterson *et al*. (1995)	
1.2	Petersen *et al*. (1995)	
0.9-1	Kaltschmitt and Hartmann (2000)	
1	Walsh *et al*. (2000)	
RPR = -0.14Y+1.96	(Fischer *et al*., 2007)	"Y" refers to the crop production ratio (t/ha)
RPR = 1.822*exp(-0.149*Y)	(Bentsen *et al*., 2014)	"Y" refers to the crop production ratio (t/ha)
RPR=0.769−0.129*ATAN((Y−6.7)/1.5)	Edwards RAH, Šúri M, Huld TA, Dallemand JF. GIS-based assessment of cereal straw energy resource in the European Union. In: Proceedings 14th Eur. biomass conference exhib. ETA-renewable energies WIP-renewable energies; 2005	"Y" refers to the crop production ratio (t/ha)

Table 14. Maize residue to product ratio

RPR Maize		
RPR	**Source**	**Comments**
0.2-2.0	Ramesh *et al.* (2019)	
1	Ericsson and Nilsson (2006)	
1	Glassner *et al*. (1998)	
0.9	Johnson *et al*. (2006)	
0.9-1.1	Kadam and McMillan (2003)	
2	Koopmans and Koppejan (1997)	
1.3	Koukios (1998)	
0.75-1	Linden *et al*. (2000)	
1	Nelson (2002)	
0.7	Panoutsou and Labalette (2006)	

0.8-1.2	Sokhansanj *et al.* (2002)	
1	Walsh *et al.* (2000)	
1	Wilhelm *et al.* (2004)	
RPR = -0.27*Y+2.77	Fischer *et al.*, 2007	"Y" refers to the crop production ratio (t/ha)
RPR = -0.1807*ln(Y)+1.3373	Scarlat *et al.*, 2010	"Y" refers to the crop production ratio (t/ha)

The key considerations assumed have been summarized in Table 15.

Table 15. Consideration for the BIOEAST region

BIOEAST region's considerations		
Parameter	**Value**	**Comment**
Crop harvesting standard humidity (%) (wet basis)	14	Considering literature review and ratio determined in the field test performed in different projects (AGROinLOG, Up-running, Europrunning)
Wheat RPR	1.2	
Moisture content wheat straw at biorefinery gate (%) (wet basis)	20	
Barley RPR	1.3	
Moisture content barley straw at biorefinery gate (%) (wet basis)	20	
Maize RPR	1	
Moisture content corn stalk and cob at biorefinery gate (%) (wet basis)	35	

Based on the considerations mentioned and the crop data consulted in EUROSTAT database, the wheat and barley straw, and corn cob and stalk potential are depicted in Figure 31, Figure 32 and Figure 33.

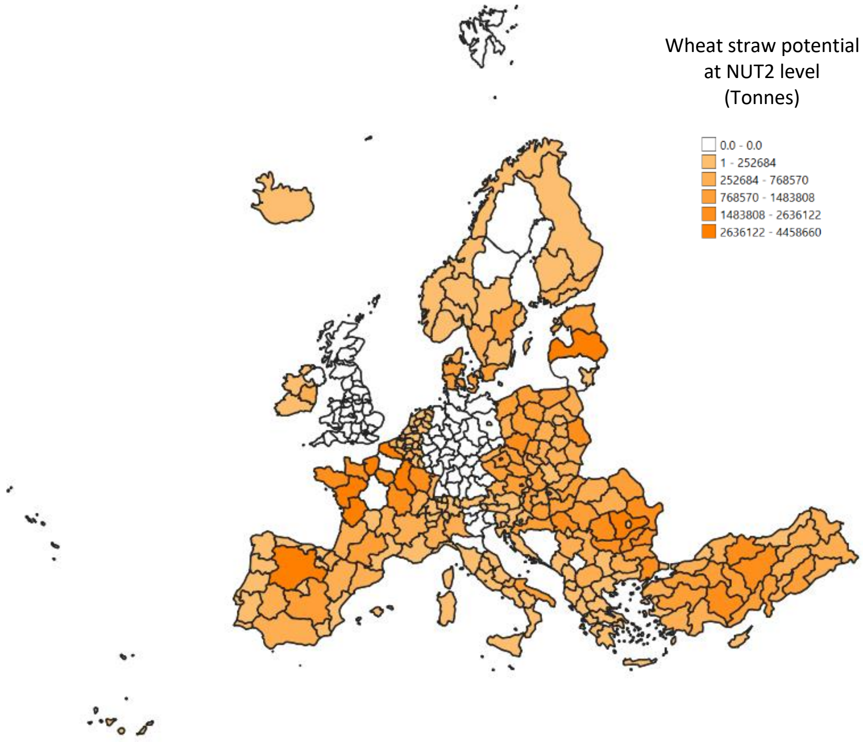

Figure 31. Wheat straw potential

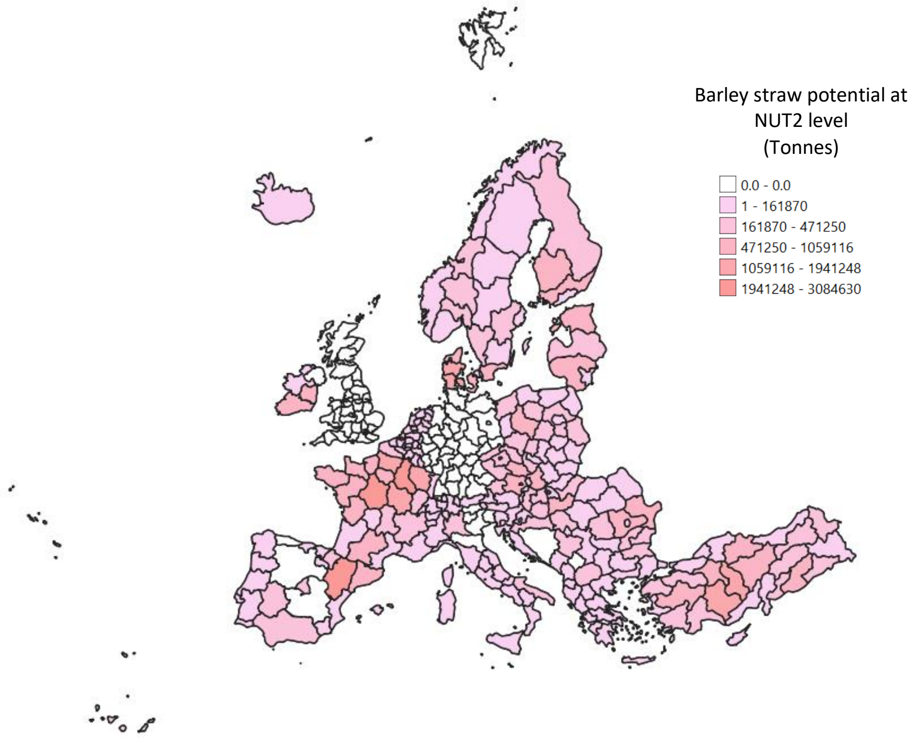

Figure 32. Barley straw potential

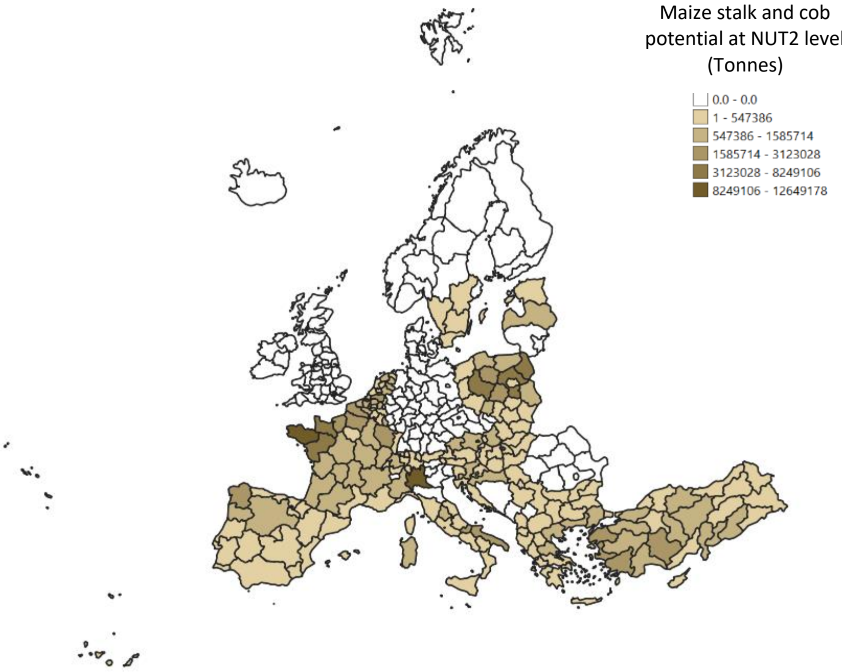

Figure 33. Maize cob and stalk potential

The three crops assessed have a very wide distribution in the European territory and all three can be found in practically all BIOEAST region. This reinforces the interest in establishing the keys of success of the business models developed in the project, that can be transferred to the development of new business models focused on the valorisation of wheat and barley straw and maize stalk and cob.

The biomass assessment, especially for the straw case, should consider that the use of straw for other applications is quite extended and therefore the potential available is most likely quite reduced (in average 50-60% based on the experiences from previous field tests). Therefore, when developing new biobased value chain in these regions, business models should be adapted to the feedstock and regional specificities and the biomass assessment should be refined to consider the availability. In this sense, determining the availability ratio requires to consider different aspect such as regional/local and market flows (import/export) that are beyond the scope of the assessment performed. The current assessment focuses on the identification of most promising NUT2 regions to transfer the business models developed by BRILIAN pilots and the keys for success based on the feedstocks' potential.

One of the aspects that could affect the adoption of these business models is precisely the lack of baseline information, since, in the process to implement such initiatives, the subsequent phases would require a more detailed analysis to consider for instance availability of the feedstock at regional level which are fundamental to assess the bio-based value chain feasibility.

6. CONCLUSIONS

Based on the results of the evaluation, the regions demonstrating the highest potential for replicating the business model piloted in Spain include France, Belgium, Germany, Poland, Sweden, Netherlands, and Romania. The replicability of the Spanish pilot business model will be more suitable in regions where agro-industries devoted to potato products commercialization can be identified, in which the percentage of rejection is higher, the installation of recovery equipment and the necessary infrastructure (extraction plant, etc.) is viable and the market potential of the bio-product generated (starch) is significant. Considering the low percentage of losses associated with the logistics of the resource, actions aimed at reducing this percentage or valorising them around the origin area have less projection.

The most significant potential for replicating the Danish pilot case can be observed in France, Denmark, Sweden, central areas of Spain, and eastern European countries like Lithuania, Latvia, Estonia, Poland, Czechia, Slovakia, Hungary, Romania, and Bulgaria. The potential replication of the Danish pilot case may be more applicable in regions where there is a close association with rapeseed oil extraction activity. However, the key considerations for successful implementation will revolve around scaling up the valorisation technology and the necessary investments.

The highest potential for transferring the business model based on valorising sunflower cake, developed by the Italian pilot, can be identified in Spain, France, and eastern European countries such as Slovakia, Hungary, Romania, and Bulgaria. In turn, the business model focusing on safflower cake demonstrates significant potential for replication in Belgium, Denmark, France, Italy, the Netherlands, Portugal, and Spain. The feasibility of replicating this valorisation scheme, which is based on by-products from seed crushing and pressing, is higher in regions where farmers have formed cooperatives or associations to ensure a viable quantity of product for profitable installation of pressing equipment, if not already in place. However, it is essential to consider the current utilization of seed cake as well, with regions not currently utilizing this by-product being more attractive for model replication. Given that cardoon and safflower are intended for cultivation in marginal lands, regulations governing the cultivation of crops in marginal or abandoned areas should be examined, as differences in regulations among regions may be worth noting.

The residues or side streams with the highest potential in the BIOEAST region are the straw from wheat and/or barley straw and corn stalk and cob. Nonetheless, the business models of the Spanish and Danish pilot cases also demonstrate a notable potential given the relevance of these crops in the BIOEAST region.

One factor that could impede the acceptance of these business models in eastern nations is the absence of input data. In the implementation of bio-based value chains, subsequent stages would necessitate a more comprehensive and detailed analysis for the specific region, including an evaluation of feedstock availability at the regional and local level, which is crucial in assessing the feasibility of the bio-based value chain.

Moreover, the utilization of the produced bio-products (such as biostimulants, bioherbicides, and bioplastics for mulching or packaging) by the primary producers engaged in the initial phase of this value chain significantly enhances the environmental and social impact.

7. DEVIATIONS

No deviations from the planned technical progress.

8. REFERENCES

[1] Sophia, Mouas, Bourbia., Habiba, Kazeoui., Rafik, Belarbi. (2023). A review on recent research on bio-based building materials and their applications. Materials for Renewable and Sustainable Energy, doi: 10.1007/s40243-023-00234-7.

[2] A.A., Korotkova., E., A., Sergeenko., V., N., Khramova. (2023). Biotechnological aspects of the development of milk-protein bio-products using alternative bioorganic raw materials. Аграрно-пищевые инновации, doi: 10.31208/2618-7353-2022-19-49-59Example.

[3] Stefano, Ciliberti., Gabriele, Chiodini., Angelo, Frascarelli. (2018). The role of the CAP in fostering the diffusion of institutional hybrid arrangements: three case studies from Italy. doi: 10.13128/REA-25102.

[4] Jochen, Kantelhardt., Christian, Ganzert., Christine, Krämer. (2008). Consequences of the cap reform on farm activities and the environment – results of an empirical study. Research Papers in Economics.

[5] Israel, Dunmade. (2020). Application of Lifecycle Concepts in the Conversion of Biomass to Value-Added Commodities. doi: 10.1007/978-3-030-38032-8_25

[6] Ivan, Camilo, Vera, Concha. (2022). Land for biomass?. doi: 10.33540/1423

[7] Statistics explained. (n.d.). https://ec.europa.eu/EUROSTAT/statistics-explained/index.php?title=Agricultural_production_-_crops#Cereals

[8] Ministerie van Landbouw, Natuur en Voedselkwaliteit. (2023, January 19). EUROSTAT: Romania ranks fourth In the EU by wheat crop in 2022. Nieuwsbericht | Agroberichten Buitenland. https://www.agroberichtenbuitenland.nl/actueel/nieuws/2023/01/18/romania-is-on-4th-place-in-the-eu-by-wheat-crop-in-2022

[9] EUROSTAT (2023), Key figures on the European Food Chain – 2023 Edition, Publications Office of the European Union, https://ec.europa.eu/EUROSTAT/documents/15216629/18054337/KS-FK-23-001-EN-N.pdf

[10] https://ec.europa.eu/EUROSTAT/data/database

[11] FAO database and geoportal. https://www.fao.org/geospatial/resources/data-portals/en/

[12] Project MAGIC, Grant agreement No 727698. https://iiasa-spatial.maps.arcgis.com/apps/webappviewer/index.html?id=431205b041fb4da0824782496721c1b7

[13] D2.3 Report on methodology development. Identifying Marginal Lands in Europe and strengthening their contribution potentialities in a CO2 sequestration strategy. MAIL project grant agreement No 823805. https://marginallands.eu/wp-content/uploads/2021/02/MAIL_D2.3_20210130.pdf and geoportal https://marginallandseu.users.earthengine.app/view/marginal-lands-in-europe

[14] Arshad, Muhammad Naveed & Donnison, Iain & Rowe, Rebecca. (2022). Marginal lands: Concept, classification criteria and management. 10.13140/RG.2.2.11996.46721.

[15] Sallustio, Lorenzo & Harfouche, Antoine L. & Salvati, Luca & Marchetti, Marco & Corona, Piermaria, 2022. "Evaluating the potential of marginal lands available for sustainable cellulosic biofuel production in Italy," Socio-Economic Planning Sciences, Elsevier, vol. 82(PB).

[16] Cervelli, E.; Scotto di Perta, E.; Pindozzi, S. Identification of Marginal Landscapes as Support for Sustainable Development: GIS-Based Analysis and Landscape Metrics Assessment in Southern Italy Areas. *Sustainability* 2020, *12*, 5400. https://doi.org/10.3390/su12135400

[17] Francaviglia, Rosa & Bruno, Annarita & Falcucci, Margherita & Farina, Roberta & Renzi, Gianluca & Russo, Donatella & Sepe, Lucia & Neri, Ulderico. (2016). Yields and quality of Cynara cardunculus L. wild and cultivated cardoon genotypes. A case study from a marginal land in Central Italy. European Journal of Agronomy. 72. 10-19. 10.1016/j.eja.2015.09.014.

[18] Giorgio, Grillo., Silvia, Tabasso., Giorgio, Capaldi., Kristina, Radošević., Ivana, Radojčić-Redovniković., Veronika, Gunjević., Emanuela, Calcio, Gaudino., Giancarlo, Cravotto. (2023). Food-Waste Valorisation: Synergistic Effects of Enabling Technologies and Eutectic Solvents on the Recovery of Bioactives from Violet Potato Peels. Foods, doi: 10.3390/foods12112214

[19] Rui, Galhano, dos, Santos., Patrícia, Ventura., João, C., Bordado., Maria, Margarida, Mateus. (2016). Valorizing potato peel waste: an overview of the latest publications. Reviews in Environmental Science and Bio\/technology, doi: 10.1007/S11157-016-9409-7

[20] Segundo, Eloy, López, Medina., José, Mostacero, León., Armando, Gil-, Rivero., Angélica, López, -Zavaleta., Anthony, J., De, La, Cruz, Castillo., Luigi, Villena, Zapata.

(2023). Tuberization in vitro of Solanum tuberosum L. var. "Cochacina" with purple pulp. Corpoica Ciencia y Tecnología Agropecuaria, doi: 10.21930/rcta.vol24_num1_art:2882

[21] Elli, Maria, Barampouti., Andreas, Christofi., Dimitris, Malamis., Sofia, Mai. (2021). A sustainable approach to valorize potato peel waste towards biofuel production. Biomass Conversion and Biorefinery, doi: 10.1007/S13399-021-01811-4

[22] Rajeev, Bhat. (2021). Sustainability challenges in the valorization of agri-food wastes and by-products. doi: 10.1016/B978-0-12-824044-1.00022-2

[23] Cristina, Berenguer., Carolina, Andrade., Jorge, A., M., Pereira., Rosa, Perestrelo., José, S., Câmara. (2022). Current Challenges in the Sustainable Valorisation of Agri-Food Wastes: A Review. Processes, doi: 10.3390/pr11010020

[24] Massimo, Bagnani., Silas, Ehrengruber., Wei, Long, Soon., Mohammad, Peydayesh., Ali, Miserez., Raffaele, Mezzenga. (2022). Rapeseed Cake Valorization into Bioplastics Based on Protein Amyloid Fibrils. Advanced materials and technologies, doi: 10.1002/admt.202200932

[25] Manav, Pillai. (2020). Optimization of Protein Recovery Process from Rapeseed Cake.

[26] Katariina, Rommi. (2016). Enzyme-aided recovery of protein and protein hydrolyzates from rapeseed cold-press cake.

[27] Cecilia, Ahlström. (2019). Optimization of Protein Recovery from Rapeseed Press Cake.

[28] Anne, Lomascolo., Anne, Lomascolo., Eva, Uzan-Boukhris., Eva, Uzan-Boukhris., Jean-Claude, Sigoillot., Jean-Claude, Sigoillot., Frédéric, Fine. (2012). Rapeseed and sunflower meal: a review on biotechnology status and challenges. Applied Microbiology and Biotechnology, doi: 10.1007/S00253-012-4250-6

[29] Ancuţa, Petraru., Florin, Ursachi., Sonia, Amariei. (2021). Nutritional Characteristics Assessment of Sunflower Seeds, Oil and Cake. Perspective of Using Sunflower Oilcakes as a Functional Ingredient. doi: 10.3390/PLANTS10112487

[30] Céline, Geneau-Sbartaï., Juliette, Leyris., Françoise, Silvestre., Luc, Rigal. (2008). Sunflower cake as a natural composite: composition and plastic properties. Journal of Agricultural and Food Chemistry, doi: 10.1021/JF8011536

[31] Eman, M., Salem., Najlaa, A., Hamed., Fahad, A., Awlya. (2012). Implementation of the sunflower seeds in enhancing the nutritional values of cake.

[32] Kumar, Bikash & Verma, Pradeep. (2021). Life Cycle Assessment: Blazing a Trail for Bioresources Management. Energy Conversion and Management X. 2021. 10.1016/j.ecmx.2020.100063

ANNEXES

ANNEX 1 SPANISH QUESTIONNAIRE_FIELD TO AGROINDUSTRY

Spanish pilot	
ENVIRONMENTAL	
Question	**Answer**
Potato yield in Álava region (tonnes of potatoes collected per hectare)? Crop yield in other regions supplying potatoes to UDAPA (t/ha)? Please specify if needed difference among irrigated and non-irrigated land	
Number of hectares devoted to potato cultivation from which UDAPA obtains its raw material only considering Álava region? (If the information is not available, we could use an estimation considering the amount processed and crop yield considering losses)	
Number of hectares devoted to potato cultivation from which UDAPA obtains its raw material only considering other regions besides Álava region? (If the information is not available, we could use an estimation considering the amount processed and crop yield considering losses)	
Have the different supply areas been mapped (GIS) or could you identify the field from which the potatoes are collected (polygon, plot,..)?	
Supply share of the different supply areas for UDAPA? for PATURPAT? For example, 50 % is collected at local level (within 100 km) from the	

plant, 30 % is collected from other regions of the country while 20 % is imported from Poland.	
Share of irrigated land considering the total amount processed by UDAPA **only from Álava region?**	
Share of irrigated land considering the total amount processed by UDAPA **from other supply areas besides Álava?**	
Share of irrigated land considering the total amount processed by PATURPAT **only from Álava region?**	
Share of irrigated land considering the total amount processed by PATURPAT **from other supply areas besides Álava?**	
Crop average water consumption (l/ha and year)? Please indicate if needed the difference among irrigated and non-irrigated areas and for the different supply regions	
Is harvesting always performed by mechanical means? Describe the means used	
Please describe the agricultural work carried out during the vegetative cycle of the crop ploughing, harvesting, application of pesticides, fertilizers, etc) as well as the machinery used. Additionally include the information regarding the products applied including the dosage. If some product application is not performed systematically each year and rather depends on the climate conditions or other, please comment	<table><tr><th>Activity</th><th>Regular/ Casual R/C)</th><th>Means used (machinery)</th><th>Yield (ha /h)</th><th>Product applied</th><th>Dose (tonnes/ha)</th><th>Frequency of the operation per year</th></tr><tr><td>Ploughing</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Fertilizer application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Herbicide application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Pest control application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>Harvesting</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Additional pest control application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>….</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Comments:
</td>
</tr>
<tr>
<td>Please indicate for each agricultural work the average fuel consumption</td>
<td>
<table>
<tr><td>Activity</td><td>Fuel consumption (l/ha)</td></tr>
<tr><td>Ploughing</td><td></td></tr>
<tr><td>Inorganic fertilizer application</td><td></td></tr>
<tr><td>Organic fertilizer application</td><td></td></tr>
<tr><td>Herbicide application</td><td></td></tr>
<tr><td>Pest control application</td><td></td></tr>
<tr><td>Harvesting</td><td></td></tr>
<tr><td>Additional pest control application</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Incorporation of rapeseed straw to the soil</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table>
</td>
</tr>
<tr>
<td>Please indicate if there is an electricity consumption associated to the irrigation or any other process carried out at the field as well as during the storage, drying or other and quantify it (kWh/year)</td>
<td>
<table>
<tr><td>Activity</td><td>Electricity consumption (kWh/year)</td></tr>
<tr><td>Irrigation</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>…</td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>
</td>
</tr>
<tr>
<td>Please indicate if there are losses (%) along the value chain (from the</td>
<td>
<table>
<tr><td>Activity</td><td>Losses (%)</td></tr>
<tr><td></td><td></td></tr>
</table>
</td>
</tr>
</table>

harvesting to the storage of the potatoes at UDAPA's warehouse)? (Losses during the harvesting, loading of the trailer, unloading at the intermediate storage/warehouse, pretreatments, storage, etc.)	<table><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>
Who carries out the transport from the field to the agroindustry (type of actor: cooperative, farmer, transport company, agroindustry, etc.)? Additionally, please indicate the mean used and average fuel consumption (l/km)	
Average distance from the fields where the potatoes are collected to the agroindustry (distance from UDAPA facility to the fields considering Álava region supply area only)?	
Average distance from the fields to UDAPA facility considering other supply areas besides Álava region (if not possible please mention the supply regions)?	
Please specify the average moisture content (% dry bases) according to the supply zone, potato variety potato or fields characteristics (for instance irrigated or non-irrigated) once the farmer unloads the load at UDAPA's warehouse?	

Spanish pilot	
ECONOMIC	
Question	**Answer**
What is the cost of diesel fuel (in € excluding VAT) used for the different operations at the field, transport, pretreatments? Please specify if there are differences	<table><tr><td>Activity</td><td>Diesel cost (€ excluding VAT)</td></tr><tr><td>Ploughing</td><td></td></tr><tr><td>Inorganic fertilizer application</td><td></td></tr></table>

<table>
<tr><td>according to the step of the value chain</td><td>
<table>
<tr><td>Organic fertilizer application</td><td></td></tr>
<tr><td>Herbicide application</td><td></td></tr>
<tr><td>Pest control application</td><td></td></tr>
<tr><td>Harvesting</td><td></td></tr>
<tr><td>Additional pest control application</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Incorporation of rapeseed straw to the soil</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table>
</td></tr>
<tr><td>What is the cost of gas (in € excluding VAT)? Please specify if there are differences according to the step of the value chain</td><td>
<table>
<tr><td>Activity</td><td>Gas cost (€ excluding VAT)</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table>
</td></tr>
<tr><td>What is the cost of biomass (in € excluding VAT)? Please specify if there are differences according to the step of the value chain</td><td>
<table>
<tr><td>Activity</td><td>Biomass cost (€ excluding VAT)</td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table>
</td></tr>
<tr><td>Cost in € (excluding VAT) of other fossil energy resources consumed for the different operations (coal, gasoline, etc.)?</td><td>
<table>
<tr><td>Activity</td><td>Fossil energy cost (€ excluding VAT)</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Cost of electricity consumed yearly (in € excluding VAT)?</td><td>
<table>
<tr><td>Activity</td><td>Electricity cost (€ excluding VAT)</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table>
</td></tr>
<tr><td>Cost of renewable electricity consumed yearly (in € excluding VAT)?</td><td>
<table>
<tr><td>Activity</td><td>Renewable energy cost (€ excluding VAT)</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Cost of tap water consumed yearly (in € excluding VAT)?</td><td><table><tr><td>Activity</td><td>Water cost (€ excluding VAT)</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Cost of irrigation water consumed yearly (in € excluding VAT)? (crop cultivation or other processes)</td><td><table><tr><td>Activity</td><td>Water cost (€ excluding VAT)</td></tr><tr><td>Irrigation</td><td></td></tr><tr><td>Other, please specify</td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Cost of organic fertilizer(s) used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of inorganic fertilizer(s) used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of herbicide(s) used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of pest control products used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of other products used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
</table>

<table>
<tr><th colspan="2">Spanish pilot</th></tr>
<tr><th colspan="2">SOCIAL</th></tr>
<tr><th>Question</th><th>Answer</th></tr>
<tr><td>Number of full-time workers employed in work associated with potato production (indicate number of months per year they are full-time or part-time all year round)?</td><td><table><tr><td>Activity</td><td>Number of full-time workers employed</td></tr><tr><td>Crop cultivation</td><td></td></tr><tr><td>Transport</td><td></td></tr><tr><td>Storage</td><td></td></tr></table></td></tr>
</table>

	Drying Other, please specify
Number of part-time workers employed in work associated with potato production (indicate number of months per year they are full-time or part-time all year round)?	Activity: Number of part-time workers employed Crop cultivation Transport Storage Drying Other, please specify
Are temporary contracts repeated from one year to the next? If yes, indicate the percentage	Activity: % Crop cultivation Transport Storage Drying Other, please specify
Percentage of women employed on temporary contracts?	Activity: % Crop cultivation Transport Storage Drying Other, please specify
Percentage of women employees with permanent contracts?	Activity: % Crop cultivation Transport Storage Drying Other, please specify
Number of women in management positions?	Activity: Number of women in management positions Crop cultivation Transport Storage Drying Other, please specify
Is there a rotation of temporary workers between different activities (potato cultivation, cooperative (UDAPA), potato	

processing at the agroindustry (PATURPAT)?	
Is the cooperative/farm involved in initiatives for the promotion of the territory where it is located or to support the community?	
Does the cooperative/farm have an ORP plan (UDAPA and PATURPAT)?	
Has a specific training activity on the concept of sustainability and best practices been implemented for employees by the cooperative/farm?	
Have other training activities been carried out/offered by the cooperative/farm for employees? Please specify the topics addressed	
Has the cooperative/farm participated in or has developed any social project in the area/region?	
Does the cooperative/farm have a system in place to ensure the flow of information to employees? Please provide a short description	

ANNEX 2 DANISH QUESTIONNAIRE_FIELD TO AGROINDUSTRY

Danish pilot	
ENVIRONMENTAL	
Question	Answer
Rapeseed yield (tonnes of rapeseed collected per hectare)? Please specify if needed differences among irrigated and non-irrigated land or among regions due to	

climatic conditions or other aspects (please specify)	
Number of hectares devoted to rapeseed cultivation from which DLG obtains its raw material? (If the information is not available, we could use an estimation considering the amount processed and crop yield, considering losses)	
Have the different supply areas (in terms of crop cultivation fields) been mapped (GIS) or could you identify the field from which the rapeseed is collected (polygon, plot,..)?	
Supply share of the different supply areas (located in different regions)? For example, 50 % is collected at local level (within 100 km) from the plant, 30 % is collected from other regions of the country while 20 % is imported from Poland.	
Share of irrigated land considering the total amount processed by DLG? Please specify if needed differences among regions	
Crop average water consumption (l/ha and year)? Please indicate if needed the difference among irrigated and non-irrigated areas and among regions	
Is harvesting always performed by mechanical means? Describe the means used	
Please describe the agricultural work carried out during the vegetative cycle of the crop ploughing, harvesting,	<table><tr><td>Activity</td><td>Regular/ Casual R/C)</td><td>Means used (machinery)</td><td>Yield (ha/h)</td><td>Product applied</td><td>Dose (tonnes /ha)</td><td>Frequency of the operation per year</td></tr></table>

application of pesticides, fertilizers, etc) as well as the machinery used. Additionally include the information regarding the products applied including the dosage. If some products application is not performed systematically each year and rather depends on the climate conditions or other, please comment

Ploughing						
Fertilizer application						
Herbicide application						
Pest control application						
Harvesting						
Additional pest control application						
….						

Comments:

Please indicate for each agricultural work the average fuel consumption

Activity	Fuel consumption (l/ha)
Ploughing	
Inorganic fertilizer application	
Organic fertilizer application	
Herbicide application	
Pest control application	
Harvesting	
Additional pest control application	
Storage	
Drying	
Incorporation of rapeseed straw to the soil	
Other, please specify	

<table>
<tr><td>Please indicate if there is an electricity consumption associated to the irrigation or any other process carried out at the field as well as during the storage, drying or other and quantify it (kWh/year)</td><td><table><tr><td>Activity</td><td>Electricity consumption (kWh/year)</td></tr><tr><td>Irrigation</td><td></td></tr><tr><td>Drying</td><td></td></tr><tr><td>…</td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Please indicate if there are losses (%) along the value chain (from the harvesting to the storage at the warehouse)? (Losses during the harvesting, loading of the trailer, unloading at the intermediate storage/warehouse, pretreatments, storage, transport to the plant, etc.)</td><td><table><tr><td>Activity</td><td>Losses (%)</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Who carries out the transport from the field to the warehouse (type of actor: cooperative, farmer, transport company, agroindustry, etc.)? Additionally, please indicate the mean used and average fuel consumption (l/km)</td><td></td></tr>
<tr><td>Who carries out the transport from the first intermediate warehouse to other warehouse (occasionally) or to DLG plant (farmers or cooperative, external transport company subcontracted, agroindustry, etc)? Additionally, please indicate the mean used and average fuel consumption (l/km)</td><td></td></tr>
<tr><td>Average distance from the fields where the rapeseed is collected to the warehouse?</td><td></td></tr>
<tr><td>Average distance from the warehouse were the farmer</td><td></td></tr>
</table>

unloads the seeds to a second warehouse?	
Average distance from the warehouse to DLG plant?	
Please specify the average moisture content (% dry bases) according to the supply zone, field characteristics (for instance irrigated or non-irrigated) or climate conditions once the farmer unloads the load at the warehouse?	
Please specify the average moisture content (% dry bases) after drying at the warehouse?	
Please specify the average moisture content (% dry bases) of the seeds once they arrive at the plant?	

<table>
<tr><th colspan="2">Danish pilot</th></tr>
<tr><th colspan="2">ECONOMIC</th></tr>
<tr><th>Question</th><th>Answer</th></tr>
<tr><td>What is the average cost of diesel fuel (in € excluding VAT) used for the different operations at the field, transport, pretreatments? Please specify if there are differences according to the step of the value chain</td><td>
<table>
<tr><td>Activity</td><td>Diesel cost (€ excluding VAT)</td></tr>
<tr><td>Ploughing</td><td></td></tr>
<tr><td>Inorganic fertilizer application</td><td></td></tr>
<tr><td>Organic fertilizer application</td><td></td></tr>
<tr><td>Herbicide application</td><td></td></tr>
<tr><td>Pest control application</td><td></td></tr>
<tr><td>Harvesting</td><td></td></tr>
<tr><td>Additional pest control application</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Incorporation of rapeseed straw to the soil</td><td></td></tr>
</table>
</td></tr>
</table>

	Other, please specify	
What is the cost of gas (in € excluding VAT)? Please specify if there are differences according to the step of the value chain	Activity	Gas cost (€ excluding VAT)
	Crop cultivation	
	Storage	
	Drying	
	Other, please specify	
What is the cost of biomass (in € excluding VAT)? Please specify if there are differences according to the step of the value chain	Activity	Biomass cost (€ excluding VAT)
	Drying	
	Other, please specify	
Cost in € (excluding VAT) of other fossil energy resources consumed for the different operations (coal, gasoline, etc.)?	Activity	Fossil energy cost (€ excluding VAT)
Cost of electricity consumed yearly (in € excluding VAT)?	Activity	Electricity cost (€ excluding VAT)
	Crop cultivation	
	Storage	
	Drying	
	Other, please specify	
Cost of renewable electricity consumed yearly (in € excluding VAT)?	Activity	Renewable energy cost (€ excluding VAT)
Cost of tap water consumed yearly (in € excluding VAT)?	Activity	Water cost (€ excluding VAT)
Cost of irrigation water consumed yearly (in € excluding VAT)? (crop cultivation or other processes)	Activity	Water cost (€ excluding VAT)
	Irrigation	

	Other, please specify	 	 	
Cost of organic fertilizer(s) used during the crop vegetative cycle (in € excluding VAT)?	
Cost of inorganic fertilizer(s) used during the crop vegetative cycle (in € excluding VAT)?	
Cost of herbicide(s) used during the crop vegetative cycle (in € excluding VAT)?	
Cost of pest control products used during the crop vegetative cycle (in € excluding VAT)?	
Cost of other products used during the crop vegetative cycle (in € excluding VAT)?	

Danish pilot	
SOCIAL	
Question	**Answer**
Number of full-time workers employed in work associated with rapeseed production (indicate number of months per year they are full-time or part-time all year round)?	Activity / Number of full-time workers employed Crop cultivation / Transport / Storage / Drying / Other, please specify /
Number of part-time workers employed in work associated with rapessed production (indicate number of months per year they are full-time or part-time all year round)?	Activity / Number of part-time workers employed Crop cultivation / Transport / Storage / Drying / Other, please specify /

<table>
<tr><td>Are temporary contracts repeated from one year to the next? If yes, indicate the percentage</td><td><table><tr><td>Activity</td><td>%</td></tr><tr><td>Crop cultivation</td><td></td></tr><tr><td>Transport</td><td></td></tr><tr><td>Storage</td><td></td></tr><tr><td>Drying</td><td></td></tr><tr><td>Other, please specify</td><td></td></tr></table></td></tr>
<tr><td>Percentage of women employed on temporary contracts?</td><td><table><tr><td>Activity</td><td>%</td></tr><tr><td>Crop cultivation</td><td></td></tr><tr><td>Transport</td><td></td></tr><tr><td>Storage</td><td></td></tr><tr><td>Drying</td><td></td></tr><tr><td>Other, please specify</td><td></td></tr></table></td></tr>
<tr><td>Percentage of women employees with permanent contracts?</td><td><table><tr><td>Activity</td><td>%</td></tr><tr><td>Crop cultivation</td><td></td></tr><tr><td>Transport</td><td></td></tr><tr><td>Storage</td><td></td></tr><tr><td>Drying</td><td></td></tr><tr><td>Other, please specify</td><td></td></tr></table></td></tr>
<tr><td>Number of women in management positions?</td><td><table><tr><td>Activity</td><td>Number of women in management positions</td></tr><tr><td>Crop cultivation</td><td></td></tr><tr><td>Transport</td><td></td></tr><tr><td>Storage</td><td></td></tr><tr><td>Drying</td><td></td></tr><tr><td>Other, please specify</td><td></td></tr></table></td></tr>
<tr><td>Is there a rotation of temporary workers between different activities (rapeseed cultivation and transport to the warehouse)?</td><td></td></tr>
<tr><td>Is the cooperative/farm involved in initiatives for the promotion of the territory where it is located or to support the community?</td><td></td></tr>
<tr><td>Does the cooperative/farm have an ORP plan (DTI and DLG)?</td><td></td></tr>
<tr><td>Has a specific training activity on the concept of sustainability and best practices been implemented</td><td></td></tr>
</table>

for employees by the cooperative/farm?	
Have other training activities been carried out/offered by the cooperative/farm for employees? Please specify the topics addressed	
Has the cooperative/farm participated in or has developed any social project in the area/region?	
Does the cooperative/farm have a system in place to ensure the flow of information to employees? Please provide a short description	

ANNEX 3 ITALIAN QUESTIONNAIRE_FIELD TO AGROINDUSTRY_Cardoon

Italian pilot	
ENVIRONMENTAL	
Question	Answer
Cardoon yield (tonnes of cardoon seeds collected per hectare)? Please specify if needed differences among irrigated and non-irrigated land or among regions due to climatic conditions or other aspects	
Cardoon straw yield? Please indicate the moisture content (dry basis) of the straw at the field and when arriving at the agroindustry/biorefinery where it will be processes	
Number of hectares devoted to cardoon cultivation from which NOVAMONT obtains its raw material? (If the information is not available, we could use an estimation considering the amount processed and crop yield, considering losses)	

<table>
<tr><td>Please indicate the use to which the land was devoted to before the crop cultivation (safflower) (for example: contaminated soil, abandoned land, forest, etc.)</td><td></td></tr>
<tr><td>Have the different supply areas (in terms of crop cultivation fields) been mapped (GIS) or could you identify the field from which the cardoon are collected (polygon, plot,..)?</td><td></td></tr>
<tr><td>Supply share of the different supply areas (located in different regions)? For example, 50 % is collected at local level (within 100 km) from the plant, 30 % is collected from other regions of the country while 20 % is imported from Spain.</td><td></td></tr>
<tr><td>Share of irrigated land considering the total amount processed by NOVAMONT? Please specify if needed differences among regions</td><td></td></tr>
<tr><td>Crop average water consumption (l/ha and year)? Please indicate if needed the difference among irrigated and non-irrigated areas and among regions</td><td></td></tr>
<tr><td>Is harvesting always performed by mechanical means? Describe the means used</td><td></td></tr>
<tr><td>For the cardoon straw please indicate the harvesting means used?</td><td></td></tr>
<tr><td>Please describe the agricultural work carried out during the vegetative cycle of the crop ploughing, harvesting, application of pesticides, fertilizers, etc) as well as the machinery used. Additionally include the information regarding the products applied including the dosage. If some products application is not performed</td><td>
<table>
<tr><td>Activity</td><td>Regular/ Casual R/C</td><td>Means used (machinery)</td><td>Yield (ha/h)</td><td>Product applied</td><td>Dose (tonnes/ ha)</td><td>Frequency of the operation per year</td></tr>
<tr><td>Ploughing</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fertilizer application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

<table>
<tr>
<td>systematically each year and rather depends on the climate conditions or other, please comment</td>
<td>
<table>
<tr><td>Herbicide application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pest control application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Harvesting</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Additional pest control application</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>….</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
Comments:
</td>
</tr>
<tr>
<td>Please indicate for each agricultural work the average fuel consumption (including those used for the straw harvesting, transport, drying, etc)</td>
<td>
<table>
<tr><th>Activity</th><th>Fuel consumption (l/ha)</th></tr>
<tr><td>Ploughing</td><td></td></tr>
<tr><td>Inorganic fertilizer application</td><td></td></tr>
<tr><td>Organic fertilizer application</td><td></td></tr>
<tr><td>Herbicide application</td><td></td></tr>
<tr><td>Pest control application</td><td></td></tr>
<tr><td>Harvesting</td><td></td></tr>
<tr><td>Additional pest control application</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Incorporation of rapeseed straw to the soil</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table>
</td>
</tr>
<tr>
<td>Please indicate if there is an electricity consumption associated to the irrigation or any other process carried out at the field as</td>
<td>
<table>
<tr><th>Activity</th><th>Electricity consumption (kWh/year)</th></tr>
<tr><td>Irrigation</td><td></td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr><td>well as during the storage, drying or other and quantify it (kWh/year)</td><td><table><tr><td>Drying</td><td></td></tr><tr><td>…</td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Please indicate if there are losses (%) along the value chain <u>(from the harvesting to the storage at the warehouse</u>)? (Losses during the harvesting, loading of the trailer, unloading at the intermediate storage/warehouse)</td><td><table><tr><td>Activity</td><td>Losses (%)</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Please indicate if there are losses (%) along the value chain (<u>from the harvesting to the storage at the plant/agroindustry</u>)? (Losses during the harvesting, loading of the trailer, unloading at the intermediate storage/warehouse, pretreatments, storage, transport to the plant, etc.)</td><td><table><tr><td>Activity</td><td>Losses (%)</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Please indicate for the <u>cardoon straw</u> yield losses along the value chain until commercialisation of the bales for mushroom growing</td><td><table><tr><td>Activity</td><td>Losses (%)</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Who carries out the transport from the field to the warehouse/processing plant (type of actor: cooperative, farmer, transport company, agroindustry, etc.)? Additionally, please indicate the means used and average fuel consumption (l/km)</td><td></td></tr>
<tr><td>Who carries out the transport from the first intermediate warehouse to other warehouse (occasionally) or to NOVAMONTplant (type of actor: cooperative, farmer, transport company, agroindustry, etc.)? Additionally, please indicate the</td><td></td></tr>
</table>

means used and average fuel consumption (l/km)	
Who carries out the transport from the field to the warehouse/processing plant for the straw (type of actor: cooperative, farmer, transport company, agroindustry, etc.)?	
Average distance from the fields where the cardoon is collected to the warehouse/processing plant (biorefinery)?	
Average distance from the warehouse were the farmer unloads the seeds to a second warehouse?	
Average distance from the warehouse to NOVAMONTplant (biorefinery)?	
Average distance from the field to the warehouse/agroindustry and/or NOVAMONTplant (biorefinery) FOR THE STRAW?	
Please specify the average moisture content (% dry bases) according to the supply zone, field characteristics (for instance irrigated or non-irrigated) or climate conditions once the farmer unloads the load at the warehouse?	
Please specify the average moisture content (% dry bases) after drying at the warehouse?	
Please specify the average moisture content (% dry bases) of the seeds once they arrive at the plant?	

Italian pilot
ECONOMIC

<table>
<tr><th>Question</th><th>Answer</th></tr>
<tr><td>What is the cost of diesel fuel (in € excluding VAT) used for the different operations at the field, transport, pretreatments? Please specify if there are differences according to the step of the value chain</td><td><table>
<tr><td>Activity</td><td>Diesel cost (€ excluding VAT)</td></tr>
<tr><td>Ploughing</td><td></td></tr>
<tr><td>Inorganic fertilizer application</td><td></td></tr>
<tr><td>Organic fertilizer application</td><td></td></tr>
<tr><td>Herbicide application</td><td></td></tr>
<tr><td>Pest control application</td><td></td></tr>
<tr><td>Harvesting</td><td></td></tr>
<tr><td>Additional pest control application</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Incorporation of rapeseed straw to the soil</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>What is the cost of gas (in € excluding VAT)? Please specify if there are differences according to the step of the value chain</td><td><table>
<tr><td>Activity</td><td>Gas cost (€ excluding VAT)</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>What is the cost of biomass (in € excluding VAT)? Please specify if there are differences according to the step of the value chain</td><td><table>
<tr><td>Activity</td><td>Biomass cost (€ excluding VAT)</td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>Cost in € (excluding VAT) of other fossil energy resources consumed for the different operations (coal, gasoline, etc.)?</td><td><table>
<tr><td>Activity</td><td>Fossil energy cost (€ excluding VAT)</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table></td></tr>
<tr><td>Cost of electricity consumed yearly (in € excluding VAT)?</td><td><table>
<tr><td>Activity</td><td>Electricity cost (€ excluding VAT)</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td>Other, please specify</td><td></td></tr></table></td></tr>
<tr><td>Cost of renewable electricity consumed yearly (in € excluding VAT)?</td><td><table><tr><td>Activity</td><td>Renewable energy cost (€ excluding VAT)</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Cost of tap water consumed yearly (in € excluding VAT)?</td><td><table><tr><td>Activity</td><td>Water cost (€ excluding VAT)</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Cost of irrigation water consumed yearly (in € excluding VAT)? (crop cultivation or other processes)</td><td><table><tr><td>Activity</td><td>Water cost (€ excluding VAT)</td></tr><tr><td>Irrigation</td><td></td></tr><tr><td>Other, please specify</td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Cost of organic fertilizer(s) used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of inorganic fertilizer(s) used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of herbicide(s) used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of pest control products used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
<tr><td>Cost of other products used during the crop vegetative cycle (in € excluding VAT)?</td><td></td></tr>
</table>

Italian pilot
SOCIAL

<table>
<tr><th>Question</th><th>Answer</th></tr>
<tr><td>Number of full-time workers employed in work associated with cardoon production (indicate number of months per year they are full-time or part-time all year round)?</td><td><table>
<tr><td>Activity</td><td>Number of full-time workers employed</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Transport</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>Number of part-time workers employed in work associated with cardoon production (indicate number of months per year they are full-time or part-time all year round)?</td><td><table>
<tr><td>Activity</td><td>Number of part-time workers employed</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Transport</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>Are temporary contracts repeated from one year to the next? If yes, indicate the percentage</td><td><table>
<tr><td>Activity</td><td>%</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Transport</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>Percentage of women employed on temporary contracts?</td><td><table>
<tr><td>Activity</td><td>%</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Transport</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>Percentage of women employees with permanent contracts?</td><td><table>
<tr><td>Activity</td><td>%</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Transport</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
<tr><td>Drying</td><td></td></tr>
<tr><td>Other, please specify</td><td></td></tr>
</table></td></tr>
<tr><td>Number of women in management positions?</td><td><table>
<tr><td>Activity</td><td>Number of women in management positions</td></tr>
<tr><td>Crop cultivation</td><td></td></tr>
<tr><td>Transport</td><td></td></tr>
<tr><td>Storage</td><td></td></tr>
</table></td></tr>
</table>

	Drying Other, please specify
Is there a rotation of temporary workers between different activities (cardoon cultivation and transport to the warehouse)?	
Is the cooperative/farm involved in initiatives for the promotion of the territory where it is located or to support the community?	
Does the cooperative/farm have an ORP plan (NOVAMONT)?	
Has a specific training activity on the concept of sustainability and best practices been implemented for employees by the cooperative/farm/agroindustry?	
Have other training activities been carried out/offered by the cooperative/farm/agroindustry for employees? Please specify the topics addressed	
Has the cooperative/farm/agroindustry participated in or has developed any social project in the area/region?	
Does the cooperative/farm/agroindustry have a system in place to ensure the flow of information to employees? Please provide a short description	