



INTEGRATED BIOMASS LOGISTICS CENTRES FOR THE AGRO-INDUSTRY

## Basic analysis of targeted agricultural sectors

European View

**Project AGROinLOG** “Demonstration of innovative integrated biomass logistics centres for the Agro-industry sector in Europe”

Prepared by: AESA


Date: 17/5/2018

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## ABBREVIATIONS

**LCIA:** Life cycle impact assessment

**LCA:** Life Cycle Assessment

**n.d.:** not determinated

## PARTNERS SHORT NAMES

**CIRCE:** Fundación CIRCE

**WFBR:** Wageningen Food & Biobased Research

**ZLC:** Fundación Zaragoza Logistics Centre

**CERTH:** Ethniko Kentro Erevnas Kai Technologikis Anaptyxis

**RISE:** RISE Research Institutes of Sweden AB

**CREA:** Consiglio per la Ricerca in Agricoltura e L'analisi dell' Economia Agraria

**APS:** Agroindustrial Pascual Sanz S.L

**NUTRIA:** Anonymi Biomichaniki Etairia Typopiisis Kai Emporias Agrotikon

**LANTMÄNNEN:** Lantmännen Ekonomisk Forening

**Processum:** RISE Processum AB


**SCO-OPS:** Cooperativas Agro-Alimentarias de España. Sociedad Cooperativa

**INASO:** Institouto Agrotikis Kai Synetairistikis Oikonomias INASO PASEGES

**AESA:** Agriconsulting Europe S.A

**UCAB:** Association Ukrainian Agribusinessclub

**UBFME:** University of Belgrade. Faculty of Mechanical Engineer

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## EXECUTIVE SUMMARY

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In task 6.1 the definition of IBLC was given as an Integrated Biomass Logistics Centre (IBLC) being a strategy for business development for agro-industries. With this, companies will be able to take business advantages, mainly related to unexploited synergies between facilities, equipment and staff capabilities.

This report presents an overview on the below mentioned sectors in respect to the EU activities.

It has to be underlined how the confidentiality of companies' agreement and information does not allow to have a complete vision of the sectors.


Therefore the following sectors and related opportunities were investigated at European level, in order to give a picture of the situation:

- Vegetable oil extraction;
- Olive mills/ Olive Oil (whole chain);
- Wineries (cellars and distilleries);
- Feed and fodder;
- Grain chain (mills-flour, straw until final product, fuel);
- Sugar industry;
- Food processing industry.

For most of these sectors interesting synergies appear, while for other ones such as feed and fodder or grain chain the synergy possibilities are mainly related to storage capabilities.

As for *vegetable oil seeds*, an interesting increase in cultivated surface, due to the biodiesel market, especially in Bulgaria, Romania, France, Hungary, Poland and Ukraine was noted. Several by-products are produced by this sector. The main interesting by-product may be hulls (for energy production) and protein cake, which is used for animal feeding. As for protein cake, the EU needs to import more protein cake to cover the existing needs. For biodiesel production, the main source in EU seems to be palm oil.

The *olive oil chain* plays a key role in IBLCs framework. The main producers are Italy, Spain, Greece and Portugal. As regards to by-products, their characteristics depend on the adopted way of oil extraction (traditional, 3-phases and 2-phases); each technology produces by-products with its own characteristics. As the sector produces prunings, these can benefit the income of the farmers and provide power (CHP). Also for mills involved in storage (e.g. cost and less time for storage) this can be of advantage, while for chemical bioproducts husk can represent a valuable source of raw materials to be processed in order to obtain chemicals and pharmaceutical products.

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As for *wine by-products*, the EU is the world wide leader in *wine production*. The main by-product of wine production is untreated/treated grape marc, that results, together with prunings, in the main by-products. Prunings are generally used in bakery ovens or, due their chemical characteristics, for production of heat in ovens. Olive husk can also be used in biochemical industry.


In this document *feed and fodder* considers mainly animal feeding, meaning the feeding of animals such as cows, pigs and other edible animals and feeding of pets as well. The production of this material comes from residues of other agricultural processes, and it is sold in the form of pellets. There are synergies in respect to new raw materials (especially proteins) produced in Europe (instead of importing them) through the development of new technologies. Other issues are the reduction of the required energy for the production process and of the use of medicine and antibiotics for animal feeding.

Since the *cereals* have to be considered as commodities, they arrive at the processing facilities already cleaned. On the contrary, rice is characterised to have the glumellae that need to be removed in preparation process. In the *grain chain*, among the straw harvesting which has to be organized at the single farm level, rice hulls seems to be the best source of biomass in order to plan an IBLC platform. This sector is able to concentrate a large amount of residual biomass. Unfortunately facilities are spread over the territory, and direct contacts and requests to stakeholders (such as suppliers, processors, etc.) are needed. The collocation on a new market should improve the business model along the supply chain. New technologies for alternative use apart burning need to be found.

The EU is the world's leading producer of *sugar beet*. Residues from sugar beets are mainly used for animal feeding and bioenergy production, likewise other technologies were and are developing to use sugar beet residues. Due to the confidential characteristic of information, no specific data can be provided. During processing, solid residues (25-30 % of the input) is made of "bagasse" and sugar beet vinasse, that are mostly used for steam generation (generally used in the facility for refining). Another use for the bagasse and other sugar beet processing residues is the integration in the mix of paper production and animal feeding.

As for the *food processing industry*, there are a lot of opportunities. In this document it is underlined how Europe's food and drink industry plays a key role in terms of turnover, value added and employment. The contribution to Europe's economy of this sector is really important: 4.25 million employees throughout the EU, over €1 trillion turnover and a positive trade balance of €25 billion. It is not possible to have a complete list of the companies in the sector, due to small structured nature of the sector as many small scale factories working for a main brand. A creation of an IBLC could be developed in plants that process fresh vegetables, using as biomass the residues and using their yards that are not used in the "off-season".

In addition, the difficulty to obtain specific and disaggregated data has to be underlined, due to the market structure and the confidential characteristics of informations.

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# 1 INTRODUCTION

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In task 6.1 of the AGROinLOG project an updated conceptual description of an Integrated Biomass Logistics Centre (IBLC) was provided.

An Integrated Biomass Logistics Centre (IBLC) is a business strategy for agro-industries which can take advantages of unexploited synergies between facilities, equipment and staff capabilities. The scope is to enhance the strenght of agro-industry, both in respect to input (food and biomass feedstock) and output (food, biocommodities & intermediate biobased feedstocks) to further increase the added value delivered by those companies. An IBLC represents four main characteristics:

- integrated value approach towards food and biobased markets;
- regional availability of biomass;
- logistic, storage operations and pre-treatment;
- exploiting the central position.

The possible synergy between two or more value chains using the same facilities basically depends on:


- period used for the main product storage/processing;
- available capacity of facilities;
- capacity of the existing buildings;
- amount of processed material per year;
- quantity of residues/by-products produced per year.

As most of these feedstocks have to be considered as commodities, their price is affected by international markets.

To define IBLC opportunities and agro-industry synergies per sector, a minimum limit of traded volume of the main product and related by-products must be established.

This report addresses the following sectors in EU' countries:

- Vegetable oil extraction;
- Olive mills/ Olive Oil (whole chain)
- Wineries (cellars and distilleries);
- Feed and fodder;
- Grain chain (mills-flour, straw until final product, fuel);
- Sugar industry;
- Food processing industry.

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## 2 VEGETABLE OIL SEEDS AND SEED OIL

### 2.1 Profile of the vegetable oil seeds and seed oil sector

#### 2.1.1 Production and volume of the sector

Since 1995, oilseed production has increased in cultivated surface due to the biodiesel market, especially in Bulgaria, Romania, France, Hungary, Poland and UK. Actually most of EU's biodiesel production seems to depend on palm oil (imported). This is because the production costs of rapeseed, canola, and other oleaginous crops in the EU is not competitive compared to palm oil production outside the EU (costs and yield; palm oil needs to be well refined, especially if it comes from Africa). In addition, seed oil production is strictly linked to protein cake production used as animal fodder.

At European level, the main representative organizations are Fediol and European Oilseed Alliance.

The main crops are rape and turnip rape (6.9 million of hectares in 2017 all over Europe of which 4.2 million of hectares are in France, Germany, Poland and UK; Figure 1) and sunflower (4.2 million of hectares in 2017 all over Europe of which 3.8 million of hectares in Romania, Spain, France and Hungary; Figure 2). Tables 1-3 presents an idea of the treated volume. Thus, these two crops cover 70 % of oilseed crops surface.

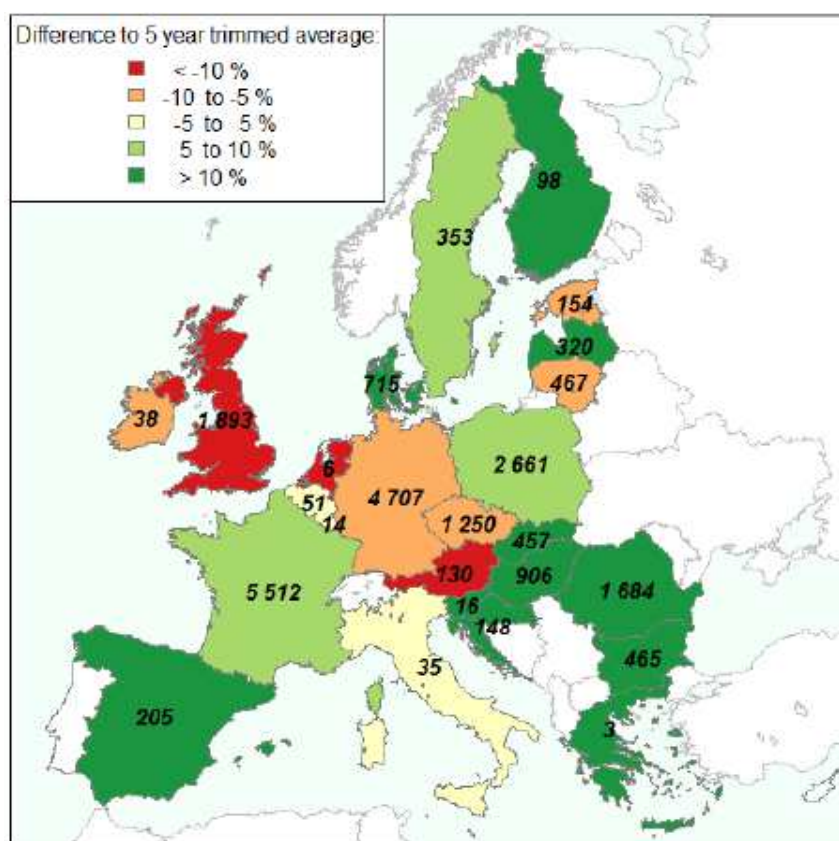



Figure 1. Rapeseed production in Europe 2017 x 1000 ton (source: EC DG Agri)

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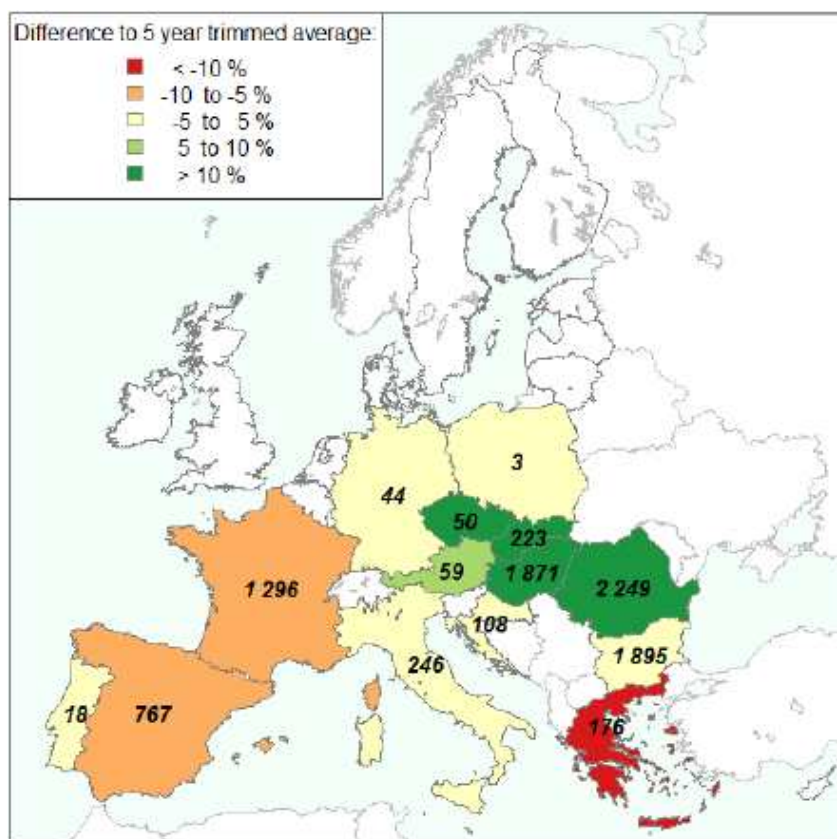


Figure 2. Sunflower production in Europe in 2017 x 1000 ton (source: EC DG Agri)


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Table 1. Oilseed crops surface cultivated in Europe: most important countries (Eurostat; x 1,000 ha)

	1995	2010	2011	2012	2013	2014	2015
EU	n.d	11,587.3	11,728.6	10,978.0	n.d	n.d	11,862.4
Czech Republic	291.0	490.4	464.41	470.8	486.9	464.3	446.0
France	1,931.3	2,239.9	2,334.6	2,336.5	2,252.1	n.d.	2,270.5
Lithuania	27.1	253.9	257.3	268.9	265.9	223.3	171.3
Hungary	547	825.6	873.8	820.1	835.9	880.6	934.2
Poland	633.8	791.4	782.4	640.7	904.9	n.d.	994.2
Romania	806.8	1,409.7	1,472.5	1,261.1	1,426.9	1,496.5	1,514.7
Slovakia	123.7	280	250.2	213.6	247.7	n.d.	244.3

Table 2. Cultivation of rape and turnip rape seeds: most important countries (Eurostat; x 1.000 ha)

	2010	2011	2012	2013	2014	2015
	EU-27	EU-27	EU-27	EU-27	EU-28	EU-28
European Union in total <sup>*)</sup>	7,105.60	6,748.21	6,208.90	6,710.67	6,714.22	6,888.70
Germany	1,461.20	1,328.60	1,306.20	1,465.60	1,394.20	1,285.50
Estonia	98.20	89.00	87.10	86.10	80.00	70.80
France	1,465.23	1,555.94	1,606.94	1,437.74	1,502.99	1,498.64
Italy	20.40	18.93	10.57	18.73	16.64	435.67
Hungary	259.30	233.90	164.92	197.65	213.72	220.56
Poland	946.10	830.10	720.30	920.70	951.10	947.10
Romania	537.33	392.67	105.30	276.60	406.71	367.89


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Table 3. Cultivation of sunflower seeds (Eurostat; x 1.000 ha)

	2010	2011	2012	2013	2014	2015
	EU-27	EU-27	EU-27	EU-27	EU-28	EU-28
European Union	3,782.15	4,367.57	4,312.63	4,623.10	4,263.09	4,196.94
Bulgaria	729.88	747.13	780.8	878.64	843.64	810.84
Greece	80.64	98.52	85.27	98.46	84.74	107.21
Spain	682.52	862.87	753.02	865.56	783.43	738.85
France	692.27	740.72	679.97	770.73	657.36	618.16
Italy	100.48	118.07	111.68	127.63	111.35	114.45
Hungary	501.51	579.55	615.1	596.89	593.73	611.64
Romania	790.81	994.98	1,067.05	1,074.58	1,001.02	1,011.52
Serbia	169.38	174.27	185.91	188.18	175.36	166.19

In 2015, more than 11.5 millions of hectares were cultivated with EU oilseeds species (e.g. sunflower, soybeans, linseeds, rape, turnip rape).

Since the other by-products already have their own market, the residues that may successfully improve IBLC's are hulls. Depending on the species, recoverable hulls vary: in soybean and rape seeds they account for 10-15 % of the weight at the final plant, while for sunflower they account for 20-50 % of the seed.

It is difficult to give a detailed frame of the processing facilities and related processed material of oil seeds all over Europe because of the intense trading and industrial information confidentiality. Therefore, crushed oilseed data for the EU is found aggregated in Table 4.




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Table 4. Crushing of oilseed in EU (Fediol; x 1.000t)

	2010	2011	2012	2013	2014	2015
	EU-27	EU-27	EU-27	EU-27	EU-28	EU-28
Groundnuts	23	34	32	32	34	34
Soybeans	12,612	12,106	12,558	13,226	13,209	14,197
Rapeseeds	22,250	22,296	22,492	23,149	24,585	24,940
Sunflower seeds	5,434	6,248	6,479	5,939	7,617	7,588
Cottonseeds	339	301	252	377	413	365
Linseeds	451	514	583	556	632	642
Sesame	0	6	21	5	0	0
Maize germs	323	280	462	376	427	498
Grape pips	93	165	155	102	92	86
<b>TOTAL</b>	<b>41,525</b>	<b>41,950</b>	<b>43,034</b>	<b>43,762</b>	<b>47,009</b>	<b>48,350</b>


Note: EU-27 without Luxemburg/Cyprus/Malta; only extra-EU imports and exports are accounted; Updated 18/08/2016

## 2.1.2 State of the sector

In the medium term a positive picture of the EU oilseed market is predicted, with a strong demand and attractive oilseed oil prices (EC, 2010) tendencies. Supply growth is expected to result mostly from a moderate yield growth and to a lesser extent from a slightly expanding oilseed production area, with some reallocation between crops. The expected increase in domestic use of oilseeds in the EU may also be driven by the growth in the emerging biodiesel and biomass industry following the initiatives taken by Member States in the framework of the RED. The trade balance is not expected to improve over the medium term as additional imports are required to meet the biofuel targets. Anyway, some limits still remain, focused on the aggregation of demand, development of farm structure, trends and processing.

## 2.1.3 Typical size of the companies

As mentioned above, it is very difficult to give a frame of the industry size, number and capacity, due to information confidentiality.

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The EU's vegetable oil and proteinmeal industry association FEDIOL, counts with a list of members that includes large companies operating at international level. When comparing these figures with other sector industries, vegetable oil industries seem to be high sized and with more available economic assets. Thus, expected investing capacity would also be high, these could potentially support the development of IBLCs.

## 2.1.4 Degree of innovation

Innovation occurs mainly in the final product processing stages and not for by-products. The only feasible solution of innovation for residues could be hull pelletizing. Soy hulls are a by-product of soybean oil and meal production, they are utilised in the form of pellet in the dairy industry as a partial replacement for forage and concentrate since the fibre in soy hulls is rapidly fermented and highly digestible. Public data on hull pellet for energy purposes, except for some academic research data, are not available or easily accessible. Some researches have been conducted for instance in Slovakia and density and hasheses were pointed out as the main constrains<sup>1</sup>.

## 2.1.5 Miscellaneous

FEDIOL conducted an LCIA (Life cycle impact assessment) of oil seed crushing to understand and quantify the magnitude and significance of potential environmental impacts.

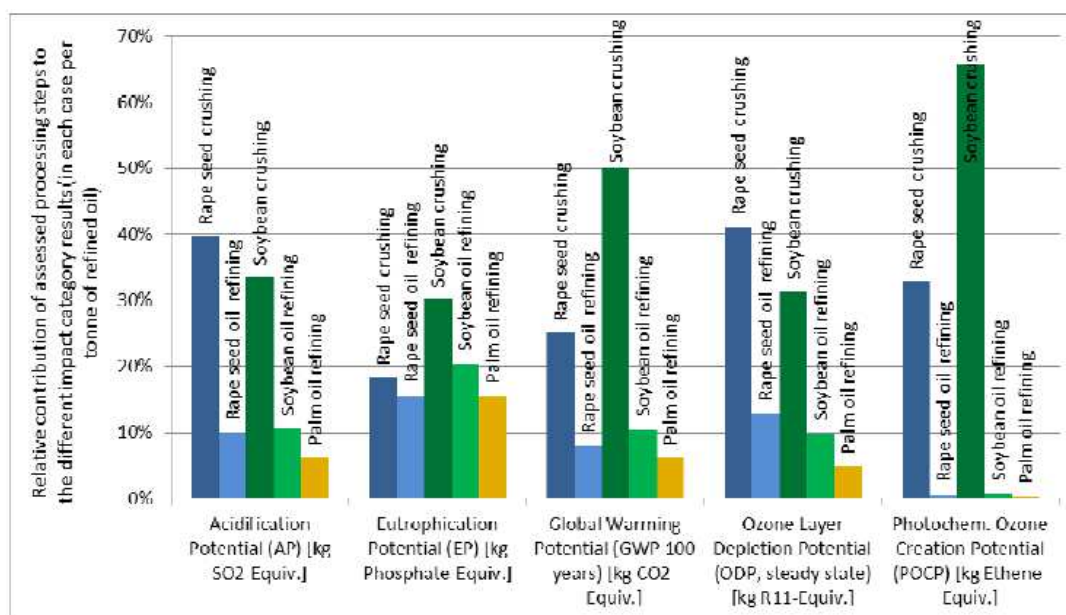



Figure 3. Relative LCIA results for the five environmental impact categories per tonne of refined oil (source: FEDIOL)

Results of the LCIA differ with the methods and on the adopted process and equipment. Emissions such as dust, chemical compounds during production (hexan) and refining and energy consumption

<sup>1</sup> <http://iopscience.iop.org/article/10.1088/1757-899X/297/1/012003/pdf>

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associated with crushing are the main contributors to the results of the LCIA. Several by-products have an effect on the level of impact. Follow-up studies, including a detailed assessment of wastewater and wastewater treatment could assess reasons behind data variations.

## 2.2 Opportunities IBLC

### 2.2.1 Sector related residues


Several by-products are produced in oilseed processing. Among the by-products generally used in chemical industry (such as stearins, olefines, glycerine), the most interesting products for the purpose of the AGROinLOG project are, according to the Italian Thermo-technical Committee:

- **Hulls:** it is the first by-product in weight of oilseed processing. In soybean and rape seeds they account for 10-15 % of the weight, while for sunflower they account for 20-50 %. They are mainly made of cellulose and lignin and could be incorporated in fodder for ruminants and rabbits, medium-density fibreboards and packaging manufacturing, microbic biomass preparation (after acid/enzymatic hydrolysis of cellulose), furfural production, energy generation.
- **Expeller:** made of seed residues in the downstream process of the mechanical crushing; the content in fatty matter varies from 8 to 15 %. The disadvantage is the potential formation of peroxides whose main hazards are their fire and explosion ones but they could also be toxic or corrosive.
- **Meal:** press cake with high protein content, residues of chemical extraction. It has a very low content in fatty matter. It is used as fodder although is not a complete feed but on the other side, its characteristics persist also in case of a long storage time.

These materials are now sent to the animal feed industry. The yield in seeds varies per crop species and per country. Table 5 reports the yield of rapeseed, sunflower and soybean in 2017 in various countries.

*Table 5. Cultivation yields in seeds for rapeseed, sunflower and soybean in the highest producing countries in EU (x 1000 ha) (Source: European Commission; 2018)*

	Rapeseed	Sunflower	Soybean
	T ha	T ha	T ha
Bulgaria	160.65	897.1	11.53
Czech Republic	394.26	21.6	15.34
Germany	1,308.9	18	19.1

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Estonia	73.79	-	-
Greece	5.01	77.1	3.61
Spain	91.21	716.33	1.66
France	1,408.42	586.7	141.03
Italy	15.62	114.45	322.42
Hungary	256.53	641.66	77.27
Poland	900	2.5	5.7
Romania	598.5	993.23	151.15
Serbia	19.4	221.7	203.1

## 2.2.2 Potential synergies & benefits


As for hulls (the only by-product that seems reliable for IBLCs), the main use may be in biopower/CHP plants. Synergies with bioenergy plants, as well as domestic heating plants, could be a good occasion to improve the positivity of the related LCIA and the economical balance of the crushing facility.

However, due to the low mass volume (density) of the bulk material, transport costs play a key role. For this reason, the shorter the transport distance is, the better is the performance of the value chain.

Pelletizing improves transport issues and should be considered. For instance (according to Debco project' results, [www.debco.eu](http://www.debco.eu)), bio power plants in Belgium use only imported pellets. If developed, this sector could represent a good opportunity for an IBLC set up. The use of European sources of feedstock could be financially beneficial.

Just to give an example, the costs of hull production are considered as part of the oil production costs. Pelletizing costs range between 10 and 12 €/t. A semi-trailer with a capacity of 20 t, can be loaded with no more than 12 t of hull pellets, and the transport cost (including handling) is around 1,5 €/km. This means that for 100 km, the price at the plant gate accounts for 24 €/t. Obviously, economies of scale would also lower the costs.

Residues could also be incorporated in fodder for ruminants and rabbits, medium-density fibreboards and packaging manufacturing, microbic biomass preparation (after acid/enzymatic hydrolysis of cellulose), furfural production.

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Although vegetable oil extractor industries could not usually have any specific equipment completely compatible with the processing of biomass, they have other valuable resources such as the access to workforce, laboratories, means of transport, etc., which could be very useful at the time of implement an IBLC in their facilities.

### 2.2.3 Market developments

In the European vegetable oils market (in term of seeds and oil) the main operators are farmers, traders, processors of oilseeds and of raw vegetable oils (producing refined oils and meals). Among them, secondary processors (such as industries for food, feed, biodiesel and bio-based material production as well as final distributors) play an important role in the supply chain. As described above, final uses range from biodiesel and oleo-chemicals industry to oil used in food industry.

Transportation and storage are very important in trading and delivering of all products and derivative products between the actors in the chain.

The market situation shows different integrations between the actors along the value chain, including all the actors. These integrations allow to increase the whole value chain. For instance, some companies processing oilseed operate also in storage and trading across the chain, while others are involved in vegetable oil processing (e.g. margarine, biodiesel and bottling). Some firms are involved in compound feed production. Over the past 20 years, the market has been characterised by several waves of company mergers and acquisitions. Due to the confidential information of companies, it is very difficult to have a complete frame of each company business.

Most of the raw material comes from EU countries and from international traders, although initial collectors such as cooperatives have an important role, in the supply chain farmers play a limited role.


For the IBLCs implementation, it may be suggested to take into account the main companies which are well integrated and have a good involvement in the market (i.e. Unilver, Bunge, Sovena, Glencore, AAK, etc.).

As for hulls, due to their physical characteristics, they are traded mainly at local level. Maybe an increase of the materials density (tons/m<sup>3</sup>), such as pelletizing, briquetting, etc. might improve the trade in the European market.

As for technical barriers, the ash content has to be taken into account: a high content in ashes could affect the bioenergy plant performances. Thus, this kind of material should be considered as part of a fuel mix. In addition, pollutant emissions during combustion have to be taken into account.

### 2.2.4 Non-technical barriers

The main non-technical barriers are related to citizens' acceptability regarding bioenergy plant emissions. As for the acceptability of the storage, transport and use of hulls, no major barriers are considered in terms of their impact on citizens.


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The composition of residues (mainly lignin), and the cost of transport and spreading make it unsuitable for its use as a soil improver.

New stricter regulations could enter into force at EU or national level, requiring tighter controls to imported raw materials, limiting the entry of required products for the vegetable oil extractors, and so, negatively affect the vegetable oil industry and, as a consequence, the implementation of IBLs.

The high investments costs for biomass processing could represent in many cases a significant financial barrier for many companies.

No other non-technical barriers are specifically foreseen for this sector.

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## OLIVE OIL CHAIN

### 2.3 Profile of the olive oil sector

#### 2.3.1 Production and volume of the sector

With more than 5 millions of hectares, the EU is the leader of the olive sector, producing around 70 % of the worlds' output. Olive production is concentrated mainly in Mediterranean area, where it plays a significant role in the agricultural economy (Figure 3) .

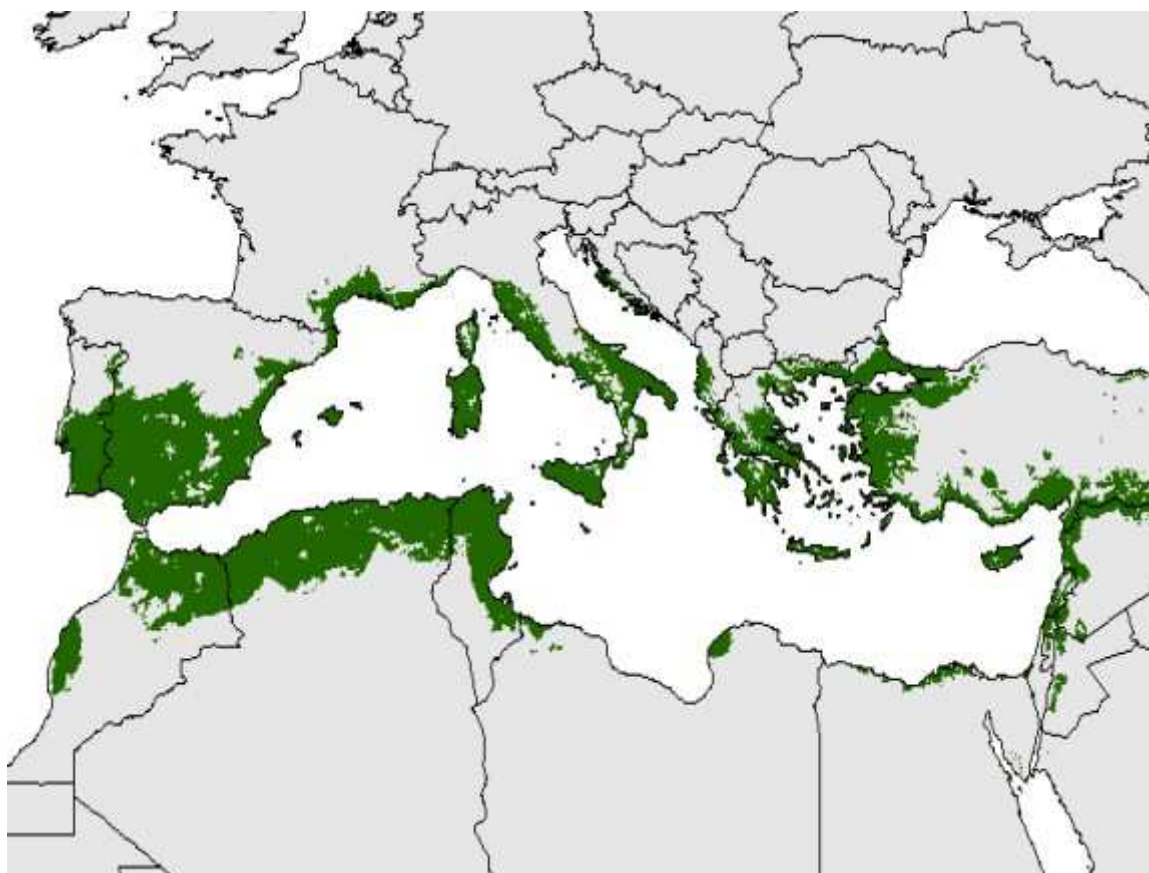



Figure 4. Distribution areas of *Olea europaea* (Source: J. Oteros, Phd thesis, University of Cordoba - Spain, 2014)

The characteristics of the olive oil are established and framed by the International Oil Council and the European Commission that define oil quality and authenticity for a correct classification. On the basis of specific analytical parameters (e.g. the free acidity, peroxide value and UV specific extinction coefficients and other markers), there are three marketable classes of olive oil: extra-virgin, virgin and lampante.

There are three technologies for olive oil extraction: i) the traditional process, ii) 3-phases decanter process and iii) 2-phases decanter process.

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In the traditional process, the ground paste is pressed between mats, in order to extract oil and water. The oil is separated by decantation. The 3-phases decanter system requires the addition of 1 litre of water per 1 kilogram of paste. After the horizontal centrifugation, the oil must be processed in a vertical centrifugal machine to separate oil from water. Finally, the 2-phases process is similar to the 3-phases process, but instead of adding water, the vegetable water is recycled.

The main difference is related to the moisture content of residues: 2-phases pomace has a moisture content of 50-70 %, while that of traditional pomace is 25-30 %. Pomace from 3-phases process has a moisture content of 40-60 %.

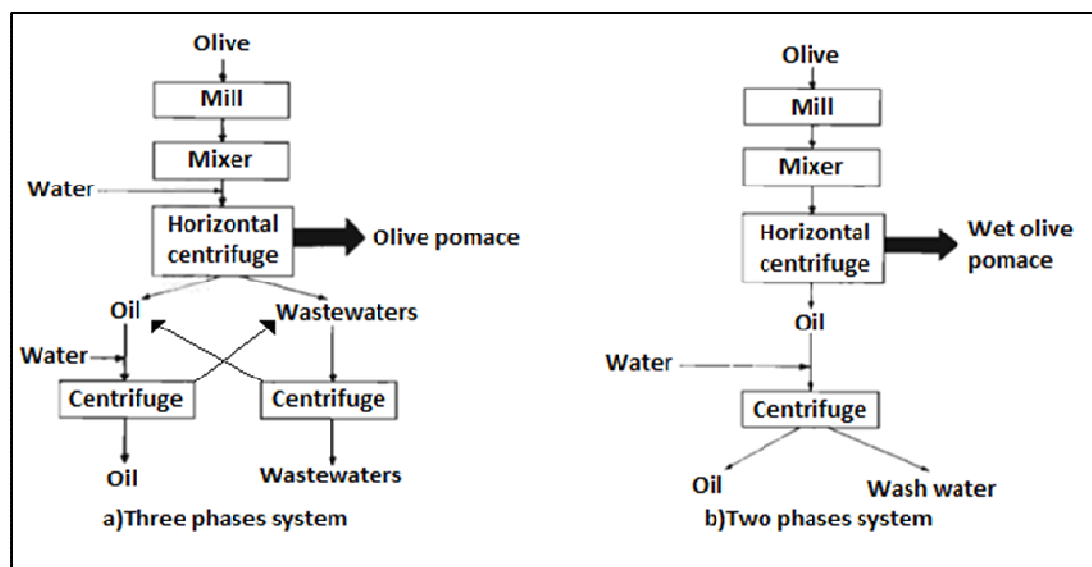


Figure 5. Comparison between three and two phases systems. Source: Expoliva, 1993

For 100 kg of processed olive, the residues/by-product are:


- for traditional extraction, 20 kg of oil, 45 kg of water and 35 kg of pomace (at 25-30 % in moisture content);
- for the 3-phases process, 20 kg of oil, 75-125 kg of water and 55 kg of pomace (at 40-60 % in moisture content);
- for the 2-phases process, 20 kg of oil, 1-2 kg of water and 78-89 kg of pomace (at 50-70 % in moisture content).

Table 6 below presents cultivated olive area in the EU in 2015.

Table 6: cultivated area with olive in EU, 2015 (x 1.000 ha)

	X 1.000 ha
EU	5,029.20
Greece	969.91



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Spain	2,526.50
France	17.21
Croatia	19.10
Italy	1,134.05
Cyprus	10.01
Portugal	351.34
Slovenia	1.08

In Spain, Italy and Portugal, the olive tree/farming surface represents 8-9 % of the total agricultural national surface (national UAA), while in Greece it is 20 %.

With reference to the total EU surface dedicated to olive farming, and taking into account only the member states with more than 1.000 ha (which is considered as the threshold in the orchard survey at EU level), the majority of olive tree cultivated is situated in Spain (53 %), Italy (24 %), Greece (15 %) and Portugal (7 %).

Other member states (France, Croatia, Cyprus and Slovenia) represent together only 1 % of the total EU surface cultivated with olive trees.

Olive trees are characterized by their longevity: the 41 % of trees in EU are less than 50 years old, while the rest could be more than 100-200 years old. More than 2.7 millions of hectares are at least 50 years old, 313 000 ha are 5-11 years old and around 130 000 ha are “young” (> 5 years old). Older trees have a higher production in prunings and represent a very interesting source of biomass. Trees older than 40 years produce the greatest amount of dry biomass per hectare (2.3 t ha) showing significant differences with trees younger than 40years (0.8-1.4 t ha)<sup>2</sup>

### 2.3.2 State of the sector

The most important producer of olive oil in EU is Spain, followed by Italy and Greece. Table 6 presents the olive oil production from 2006/2007 to 2015/2016.

Most of the produced olive oil is consumed in the main producer countries. Table 7 gives a figure of the EU production of olive oil..

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<sup>2</sup>[https://www.researchgate.net/publication/251628918\\_Quantification\\_of\\_the\\_residual\\_biomass\\_obtained\\_from\\_pruning\\_of\\_trees\\_in\\_Mediterranean\\_olive\\_groves](https://www.researchgate.net/publication/251628918_Quantification_of_the_residual_biomass_obtained_from_pruning_of_trees_in_Mediterranean_olive_groves)



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Table 7. Olive oil production from 2006/2007 to 2015/2016 (source: International Olive Oil Council; x 1.000 t)

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Cyprus	8.3	4.0	2.8	4.2	6.5	6.5	5.6	3.8	6.2	6.0
Croatia								4.6	1.1	5.5
Spain	1,111.4	1,236.1	1,030.0	1,401.5	1,391.9	1,615.0	618.2	1,781.5	842.2	1,401.6
France	3.3	4.7	7.0	5.7	6.1	3.2	5.1	4.8	1.7	5.0
Greece	370.0	327.2	305.0	320.0	301.0	294.6	357.9	132.0	300.0	320.0
Italy	490.0	510.0	540.0	430.0	440.0	399.2	415.5	463.7	222.0	474.6
Malta								0.0	0.1	0.0
Portugal	47.5	36.3	53.4	62.5	62.9	76.2	59.2	91.6	61.0	109.1
Slovenia	0.3	0.4	0.5	0.7	0.7	0.5	0.2	0.6	0.2	0.5
<b>Total</b>	<b>2,030.8</b>	<b>2,118.7</b>	<b>1,938.7</b>	<b>2,224.6</b>	<b>2,209.1</b>	<b>2,395.2</b>	<b>1,461.7</b>	<b>2,482.6</b>	<b>1,434.5</b>	<b>2,322.3</b>

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Regarding the husk price (resulting from any extraction process), one can say that it depends on the local market and the related moisture content, therefore it is difficult to give a fixed price. In fact this strictly depends on confidential agreements between companies.

Table olives present another sector. The world producer of table olive is the EU, followed by Egypt, Turkey and Algeria. Within the EU, Spain and Greece play a key role (Figures 6-7).

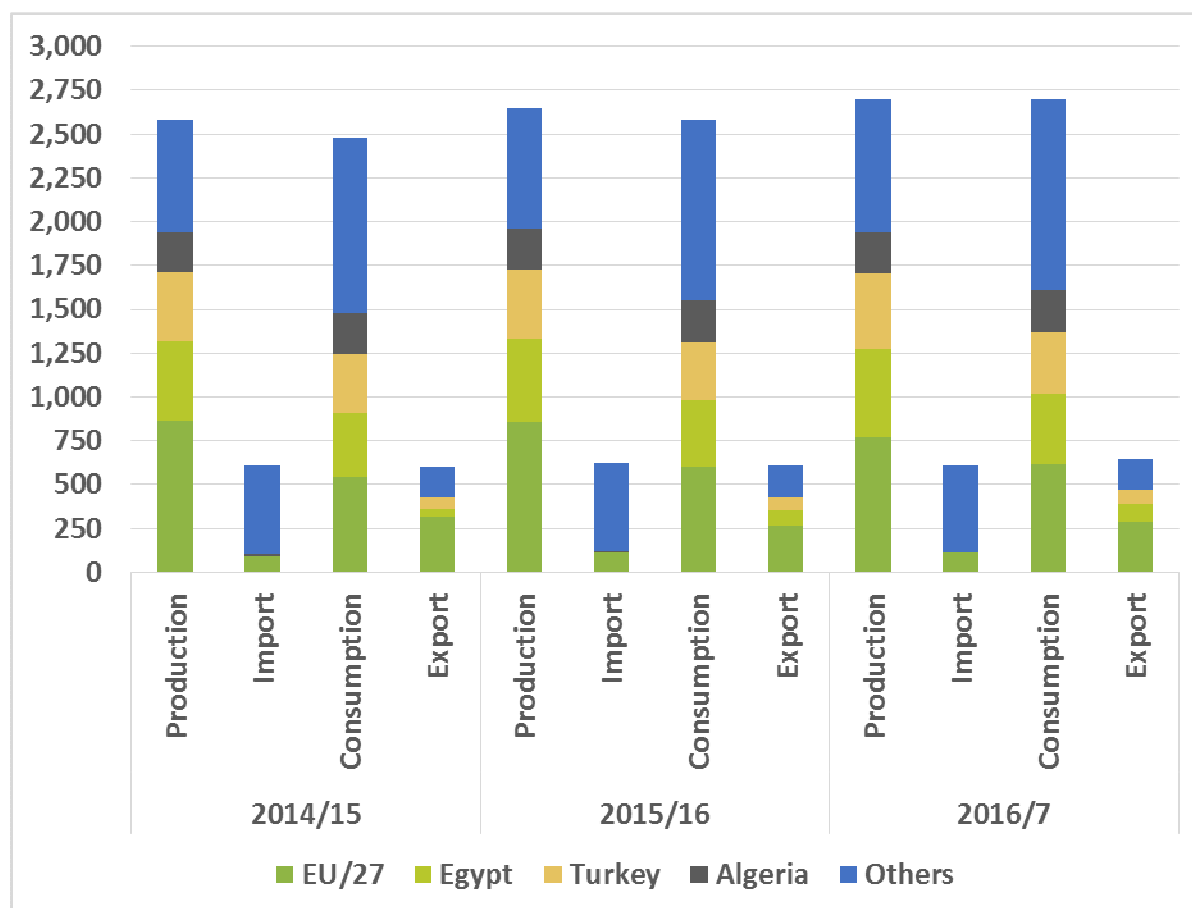



Figure 6. Table olive production, import, consumption and export (at global level; x 1.000 t; source: IOC)

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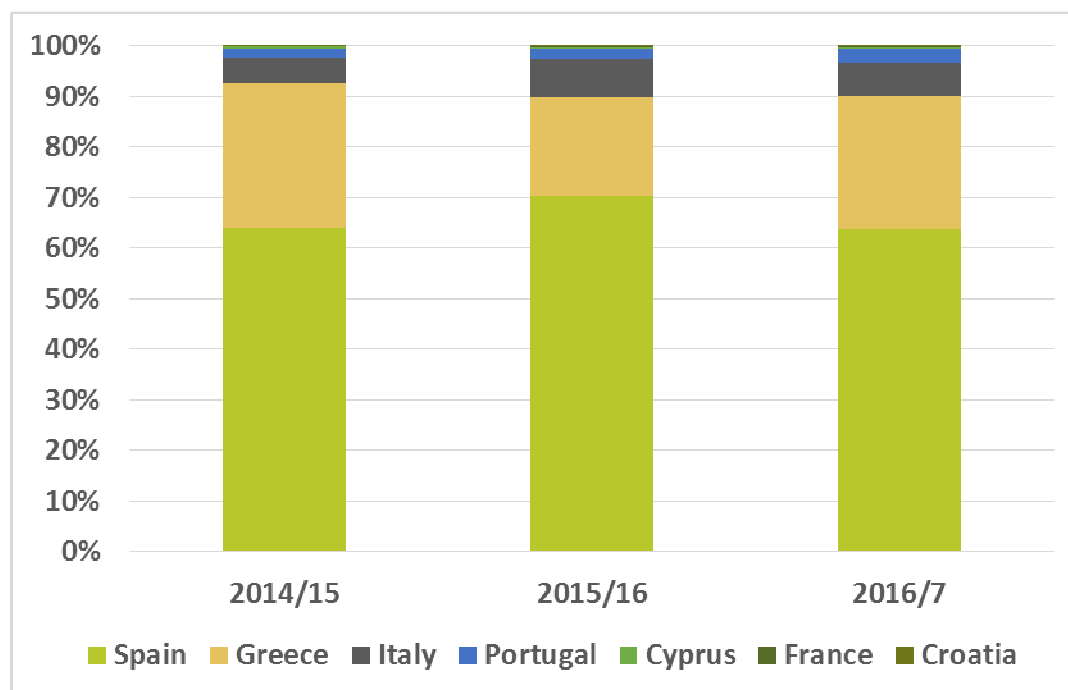


Figure 7. Table olive production within EU (source: IOC)


The main commercial table olives production processes are:

- Treated green table olives in brine: olives are treated in alkaline lye and placed in brine, in which a lactic fermentation takes place. Once the fermentation is complete, the olives need just appropriate physiological-chemical conditions to ensure their preservation: partially fermented olives are preserved by sterilization, pasteurization, addition of preservatives, refrigeration or by inert gas (without leaving them in the brine). This process is generally known as “green olives in brine”.
- Untreated natural black olives: olives are placed directly in brine and usually retain a slightly bitter taste. Preservation occurs through natural fermentation in brine. They are usually known as “natural black olives in brine”.
- Black (ripe) olives in brine: they are obtained from fruits which, when not fully ripe, have to be darkened by oxidation in alkaline lye. Through this process, the bitterness is removed. They are preserved by heat sterilization (under anaerobic conditions). The common product type is “ripe olives”.

Among these, there are other trade preparations such as: untreated black olives in dry salt, untreated naturally shrivelled black olives, dehydrated black olives, etc.

### 2.3.3 Typical size of the companies

The sector is characterized by a lot of small oil mills. In Spain, for instance, there are more than 1.800 olive oil mills. There are several brands that work with local producers both in olive mills and importing.

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Although most of such local companies do not have adequate size and conditions for the implementation of the IBLC concept in their facilities, many of them could have enough workforce and financial assets to ensure the success for the biomass related activities.

In some EU countries such as Spain, association and cooperatives including small companies of the area are present, this allow to collect more residues solving the size problem, as well as to share the investment costs and thus, reduce risk for the IBLC activities.

Unfortunately, it is not possible to get specific data.

### 2.3.4 Degree of innovation

For the olive oil sector, the most important degree of innovation is the shift of the processing from 3-phases to 2-phases processing. This allows less water to be disposed, although the moisture content in the pomace is higher. Thus, technical solutions for lowering the moisture content of pomace have to be investigated.

Innovation for both olive oil and olive for table include new stations with sensors able to collect data on atmospheric, soil, and biological parameters, such as air and soil temperature, air and soil humidity, soil salinity, leaf wetness, rainfall, solar radiation, and so on. Combined with other information, that data is used to accurately calculate a plant's need for water, identify the best time for irrigation, assess the risk of infection from pests and diseases, monitor plants' vitality, determine fertilization needs, and predict the quality and quantity to be produced.


## 2.4 Opportunities IBLC

### 2.4.1 Sector related residues

The residue from olive milling is the pomace, that can be used for domestic heating and industrial power generation. A consolidated market does not exist for this material, however, it represents a good opportunity for IBLCs since it can allow the start of new biomass activities involving different actors in agro-industry and transformation chain for the production, use and market of an high added value commodity.

According to studies done by Agriconsulting, around 5 t/ha pruning can be recovered, 3 t of dry matter per hectar (Agriconsulting ProEN.RI 2005). The recovering of such material needs a good organization and logistic (equipment and transport). Pelletizing studies are currently being conducted on the use of different type of raw materials from olive grove residues considering different physical and chemical properties of pellets, that influence the application of pellets. However, research is still needed regarding the effects of raw material characteristics, seasonal variations, collection and storage of raw material as well as the manufacturing process to facilitate a steering of production in the desired direction to produce pellets from olive pruning that meet the quality standards requirements established by other norms and in consonance with the specific application of pellets (Maravel G. et al. 2010). Therefore, pruning material should become the focus residue.

Additionally to pomace, different compounds can be extracted for several uses i.e. hydroxytyrosol and other biophenols can be extracted and they have a very high antioxidant activity (E. De Marco

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et al. 2007). Such bioproducts can improve the market and the acceptability of conversion plants. In addition, bioproducts have a very good potential market.

## 2.4.2 Potential synergies & benefits

It is expected that the development of IBLCs both in oil mills and olive pomace oil industries will increase both the employment and the length of current contracts due to the implementation of new activities and related tasks required.

Oil mills can have assets that could be of great interest for developing an IBLC. Among these can be mentioned the labour, transport, warehouses, conveyor belts and other machinery for biomass management (scales, tractors with spades, etc.), providing a useful advantage at the time of dealing with a new activity related both with bio-commodities manufacture or bio-energy production.

Moreover, prunings represent a potential benefit for farmers through income and power/CHP, as well for mills involved in storage (e.g. cost and less time for storage). For chemical bioproducts the husk can represent a good source of raw material. Among them, polyphenols are a widespread group of secondary metabolites, representing the most desirable phytochemicals because of their potential to be used as additives in food, cosmetics, medicine, and others fields (I. Volf, V. I. Popa 2018).

## 2.4.3 Market developments

Olive oil sector residues provide the opportunity of manufacture several bio-commodities demanded by markets.

Heat and power of the solid fraction and other chemicals can be extracted from solid and liquid by-products.


The most developed technologies are related to:

- Polyphenols;
- Compounds for cosmetics industry;
- Painting additives;
- Insulating Panels for construction.

## 2.4.4 Non-technical barriers


Some non-technical barriers are foreseen for pomace and pruning use for energy production. In some regions, the fuels produced from biomass are classified as “waste” and therefore it is not allowed to be used in small-scale boilers (e.g. in households). Wood biomass is used as the reference while agricultural biomass is not recognized. Regulatory barriers at the EU level create difficulties for pruning use, such as the eco-design requirements for small stoves (<50kw) and boilers (<500kw), which put stringent limits on emissions, making it likely that only A1 forestry chips and ENPLUS pellets will be able to be used (Regulation (EU) 2015/1189). This would significantly limit local markets for prunings, which are mainly used for small scale consumption. Whilst the regulations give exemptions for certain uses such as air heating, and resources such as mixed pellets of prunings and straw, this will continue to limit value chain creation (EuroPruning 2017).

Market barriers are related to the low prices of wood biomass that make it difficult for agricultural by-products to compete in a wood biomass saturated market. In addition, it is difficult for biomass

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fuels to be competitive in the market dominated by natural gas heating, especially for the agricultural biomass since its use is more complicated than natural gas. Moreover, in some countries different taxing rates are applied to raw material, product and fuel.

Finally, the use of agro-fuels compared to wood fuel requires on the one hand higher investment costs resulting from critical fuel parameters and on the other hand increased maintenance and repair costs due to abrasion and increased ash content.

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## WINERIES AND DISTILLERIES

### 2.5 Profile of the wineries and distilleries sector

#### 2.5.1 Production and volume of the sector

The EU is the world wide leader in wine production: the surface accounts almost to 50 % of the global area dedicated to vineyards, while the production in volume is 65 % (Figure 8; data are referred to 2005, but slight modifications have occurred; the aim is just to give an idea of the cultivation basin).

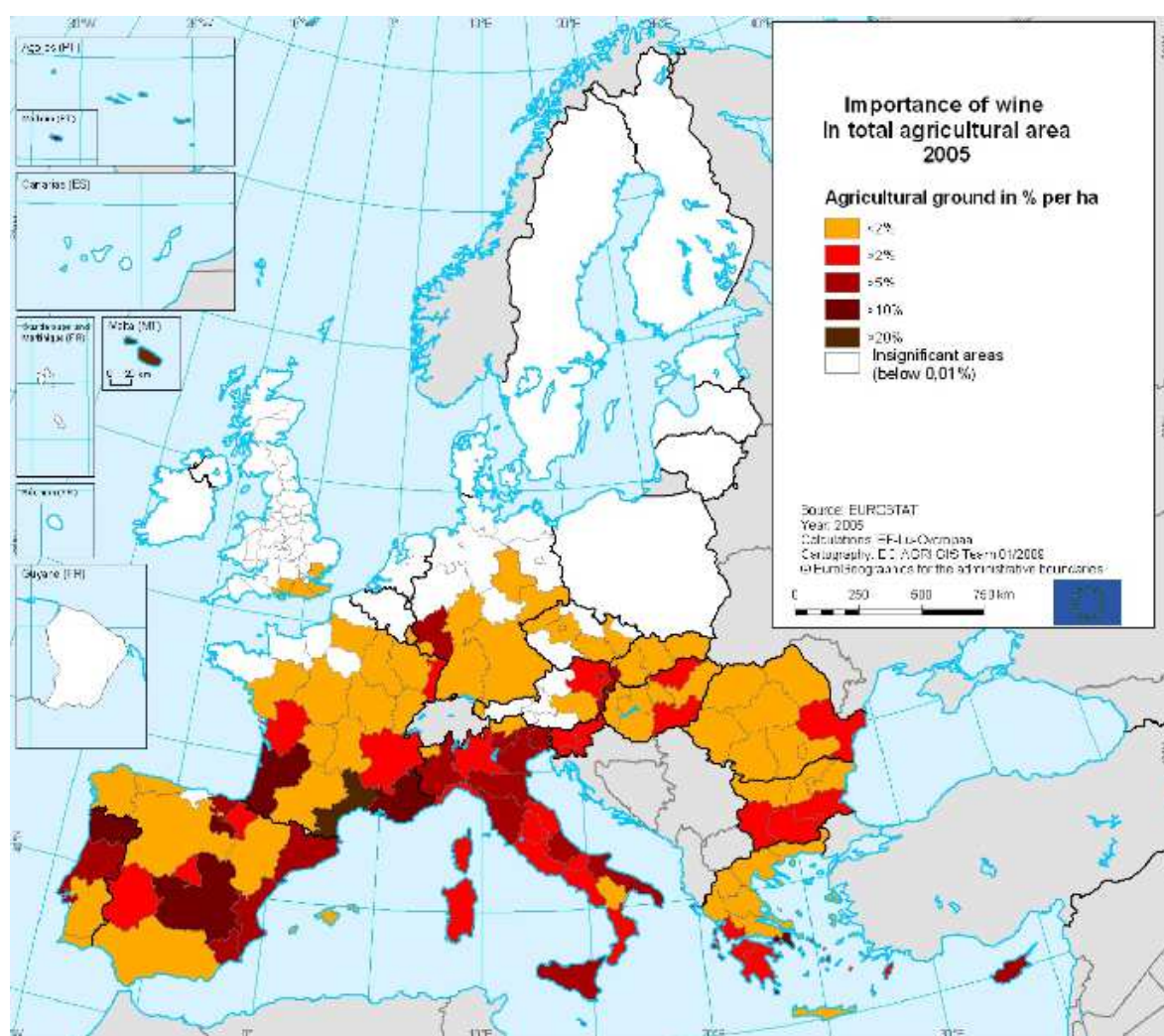


Figure 8. Wine grape surface on total agriculture area (source: Eurostat, 2017; elaborated by European Commission)

In 2014 and 2015 (Table 8), Spain represented 30 % of the total wine grape area in EU, followed by France (25 %) and Italy (21 %).




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Table 8. Most important Member States as per cultivated surface with wine grape in the EU (source: Eurostat, 2017; x 1.000 ha)

	2010	2011	2012	2013	2014	2015
<b>EU-28</b>	<b>3,218.03</b>	<b>3,112.87</b>	<b>3,088.53</b>	<b>3,090.24</b>	<b>3,049.71</b>	<b>3,044.78</b>
Germany	99.91	99.75	99.58	99.49	100.08	99.91
Greece	65.56	61.37	61.32	65.92	66.17	65.63
Spain	984.14	945.67	930.2	930.82	931.17	925.32
France	772.41	758.37	755.35	755.15	752.07	747.10
Italy	709.25	661.94	647.04	656.17	637.68	634.64
Hungary	70.16	71.82	68.86	65.96	67.37	68.94
Austria	43.66	43.84	43.62	43.62	44.79	44.79
Portugal	177.66	176.99	176.99	176.98	176.88	176.87
Romania	165.06	166.41	168.03	168.97	167.56	169.55
Serbia	22.50	22.20	21.20	21.20	21.20	21.20

As for grape production (Table 9), due to the different yield, in 2015 the main producer was Italy (30 %), followed by France (26 %) and Spain (23 %).


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Table 9. Most important EU Member States for wine grape production (source: Eurostat; x 1.000 t)

	2010	2011	2012	2013	2014	2015
<b>EU-28</b>	<b>22,497.48</b>	<b>22,937.22</b>	<b>20,887.68</b>	<b>24,611.81</b>	<b>22,612.58</b>	<b>23,647.76</b>
Bulgaria	210.40	228.50	251.40	305.9	124.93	244.78
Germany	953.41	1,251.08	1,227.18	1,139.48	1,244.82	1,199.03
Greece	611.62	530.67	566.41	598.51	598.94	574.13
Spain	5,875.65	5,565.37	5,088.00	7,224.01	5,978.49	5,527.10
France	5,868.82	6,595.27	5,326.82	5,501.21	6,156.92	6,212.82
Italy	6,426.80	5,902.90	5,861.43	6,902.04	5,932.17	7,005.60
Hungary	279.08	431.18	340.41	433.97	390.46	457.92
Austria	231.66	375.3	287.3	318.93	266.49	302.45
Portugal	928.17	730.52	823.71	810.27	804.08	915.60
Romania	684.95	817.96	693.04	932.75	743.81	752.85
Serbia	171.99	193.98	149.22	199.95	122.49	170.65

## 2.5.2 State of the sector

Europe is the largest producer of wine in the world, and most of this production is concentrated in the south. Most opportunities for developing countries can be found in the other countries, such as the United Kingdom, the Netherlands, Austria, Germany and Belgium. Due to insufficient domestic production in these countries, consumers are more open to foreign wines. Although the Eastern European markets are still relatively small, wine markets there are growing and also provide opportunities.

Besides wine grape production, the amount of wine produced in EU is reported in Table 10.


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Table 10. Wine production in EU\*) (source: FAS Europe Offices; x million litres)

	2012/2013	2013/2014	2014/2015
France	4,136	4,149	4,650
Italy	4,412	5,243	4,442
Spain	3,560	5,355	4,161
Germany	900	838	930
Portugal	630	624	589
Romania	410	520	370
Greece	311	334	290
Other EU-28 countries	701	990	853
<b>EU-28</b>	<b>15,060</b>	<b>18,053</b>	<b>16,285</b>

\*) Volume of product removed from fermenters after the first natural fermentation of the must of fresh grapes (juices and other musts excluded)


The most important countries in terms of wine production are France, Italy and Spain, producing 23-30 % each of the EU-28 total production.

Total European wine exports amounted to €18.7 billion in 2015, recording an average annual increase of 3.8% between 2011 and 2015. About 55% of European exports is destined to end up in other European countries. Countries in Eastern Europe are also becoming attractive destinations for European wine. Although exports to Eastern European countries are still small, exports to Poland and Czech Republic recorded annual increases of 9.0% and 1.1% respectively in 2015. Other attractive export markets for European wines are traditionally the United States, Japan, Canada and Singapore. Those countries are seeing an increase in wine consumption. Spanish wines are increasingly exported to Japan because of the favourable price/quality ratio. Due to an economic crisis in Russia, European wine exports to Russia declined by 27.7% in 2014. China is an emerging destination for European wine (4.1% average annual increase in wines from Europe since 2011) (CBI NL 2016)<sup>3</sup>.

### 2.5.3 Typical size of the companies

Small cellars with “in-house” grape processing can be found commonly throughout the EU. The sector is characterised also by cellars collecting wine grape (private and co-operatives) that process it. To understand this better, further analysis for each country is needed.

<sup>3</sup> <https://www.cbi.eu/market-information/wine/what-demand/>

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Since the main biomass is grape, IBLCs opportunities should concentrate in distilleries. Considering their wide experience in residues management, the ownership of compatible equipment with the biomass processing and the considerable amounts of raw material that distilleries usually receive, these industries are very likely to become succesful IBLC's.

## 2.5.4 Degree of innovation

The wine sector is characterized by the fatc that from one side is anchored to a sector that sometimes could be reluctant to innovation like the agrarian one and, by the other side, to another more active on innovation like food and beverages sector.

As for the innovation degree, data from the European AGROinLOG partner show that the most important innovations are related to increasing the efficiency of the fermentation and extracting processes, as well the cost reduction.

Over the last few years, Europe saw a significant progress in improving technologies for viticulture and enology and in improving wine quality and production of wine with geographical indication. Legislative Decree 61/2010, replaced by Law No. 238 of 12 December 2016 “Regulation on the organic cultivation of grapes and the production and trade of wine”, with which the previous Law 164/1992 on designations of origin for wines was revised at national level, established that DOCG and DOC wines merge together in the PDO wine category, while IGT wines are identified with the acronym already in place for similar food products (PGI). The new regulation renders the link between the wine's characteristics and its geographical origins even stronger, as the link with the territory is specified in the product specification. It is obligatory for the vinification and bottling areas to correspond; there is loss of right to claim a particular designation for musts and wines that are suitable to become a PDO or PGI if they are not produced within the specific production area (Qualivita foundation, 2017).


A new generation of sensor-driven viticulture tools is giving growers the ability to monitor and measure their vines. Unfortunately, most of new technologies aiming to this are strictly confidential, and no detailed information can be given at European level. Some projects have been funded by the European Framework Programmes i.e. ORWINE whose aim was the development of environment and consumer friendly technologies for organic wine quality improvement and scientifically based legislative framework (CORDIS).

## 2.6 Opportunities IBLC

### 2.6.1 Sector related residues

The main by-products of wine production are untreated grape marc and the prunings. Although prunings collection on fields could play a key-role, grape marc is the residues offering the best opportunities for IBLCs because exhausted grape pomace can be used for the extraction of bio-compounds (such as polyphenols, tartaric acid or grape seed oil), feed manufacturing, compost production or as a solid biofuel for energy production.

Untreated grape marc is made of:

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- Skins;
- Grape seeds, (2-3 per grape berries). They have a hard epidermis protecting them from fermentation and distillation, they can be separated from the marc for oil extraction;
- Stalks, that can be present or not. They affect the storage of the marc.

Table 11 reports the product and by-products of grape.

*Table 11. Average yield in products and by-products of processing 100 kg of grape (source: Agriconsulting).*

Typology	Quantity (kg)
Must (skin excluded)	80-85
Skins	9-10
Grape seeds	3-4
Stolks	3-4

Must (with or without skins, depending on the vinification process) is sent for fermentation to produce wine. When the vinification is completed, the skins are removed. Seeds can be used for oil extraction or left in the marc. Marc is then sent to distilleries, in order to obtain ethanol (spirit, grappa, etc.). Distilleries also blend untreated grape marc with wine lees (the residue decanted in the fermenter, made of inactive yeast residues, potassium salt and tartaric acid). The final product of distilleries is the exhaust marc. It can be used for feeding (in mix with other products), or be mixed with grape stalk, for energy production. Wine residues can have other uses in the following markets:

- Direct on-field agronomical use (the quantity per hectares depends on national and local legislation and soil characteristics);
- Indirect on-field agronomical use, through conversion into fertilizers;
- Energy use;
- Pharmaceutical, cosmetic use and other bioproducts production;
- Extraction of polyphenols, enocyanin and other compounds for feed industry.

Table 12 estimates the gross availability of by-products per country. After distillation, 90-95 % of the residues are obtained.


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Table 12. Estimation of by-product production from grape for the most important wine producers in the EU (x 1.000 t; 2015)


	Grape processed	Skins	Grape seeds	Stalks
<b>EU-28</b>	<b>23,647.80</b>	<b>2,246.50</b>	<b>827.7</b>	<b>827.7</b>
Germany	1,199.00	113.9	42	42
Greece	574.1	54.5	20.1	20.1
Spain	5,527.10	525.1	193.4	193.4
France	6,212.80	590.2	217.4	217.4
Italy	7,005.60	665.5	245.2	245.2
Hungary	457.9	43.5	16	16
Austria	302.5	28.7	10.6	10.6
Portugal	915.6	87	32	32
Romania	752.9	71.5	26.3	26.3

In addition, prunings represent a good source of biomass. According to Agriconsulting experience, their recovering (at least 2 t/ha of dry matter) requires setting up a logistic plan (e.g. in the south of Italy there are companies specifically working in this field). The destinations cover power production, gunpowder production as well as the extraction of chemical compounds.

Pellet from vineyard residues fulfil the specifications of the type B non-woody pellets (European Pellet Council 2011<sup>4</sup>); however, during combustion test of vineyard-based pellet the high emission of CO indicates incomplete combustion; and vineyard-based pellet NO<sub>x</sub> emissions are more than double compared to those obtained during the control tests, confirming that the analysed vineyard-based pellets are unsuitable, as they are, for use in traditional pellet stoves (Zanetti et al., 2017). Moreover, since vineyards are exposed to treatments based on Cu and Zn, those metals last in wood residues during the pruning while the European Standard about general requirements of solid biofuels establishes Cu values for different biomasses for energy use. As a consequence, the use pruning residues is preferably in large-scale power plants with appropriate emission filters instead of small-scale boilers or plants (D. Duca et al. 2016).

Another by-product is the seed which, for its oil quality, has its own market all over Europe for pharmaceutical uses. Grape seed oil is an excellent cosmetic ingredient for controlling moisture of

<sup>4</sup> <http://www.infobio.ru/sites/default/files/ENplus-handbook-3.5.11.pdf>

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the skin. According to a report of an independent study published in Free Radical Biology and Medicine, grape seed oil can also accelerate the healing process of wounds on human skin and can also be valuable for the cure of any acne problems. It is rich in vitamin E, linoleic acid, omega fatty acid and antioxidants and it provides moisture and protection against free radicals. As stated by the University of Maryland Medical Center, grape seed oil is able to increase the amount of antioxidant in the blood and to maintain the existence of collagen and elastin (E. Sotiropoulou et al. 2015)<sup>5</sup>.

## 2.6.2 Potential synergies & benefits

The main synergies regard the storage yards and use of marc for energy and bioproducts production. Marc is generally stored in piles (preferably under a roof), while prunings can be stored in piles (if they are already chipped on field) or in bales. Among storage yards, good synergies can be reached with the bioproducts production. Also here, the confidentiality of information plays a key role.

Residues for energy production have already been tested and used. But results on grape marc components put in evidence some difference in terms of ash and chemical elements content, which represent, specifically for these materials, the most critical aspects to take into account in combustion heating systems.

Other by-products show minor potential synergies.

## 2.6.3 Market developments


Wine sector residues offer the opportunity to extract several bio-compounds with a wide range of benefits applied to different fields and, thus, arising as a chance for targeting different markets from food, feed to bio-based ones.

By-products are used mainly for energy generation (burning in form of chips). Most of the harvesters produce bales while others produce short sticks limiting soil contamination and preserving biomass quality.

Actually new technologies are emerging for chemical compounds (e.g. Anthocyanins, Flavonoids, etc.). Due to the increasing cost of chemicals and the increasing demand for sustainable sources, the by-products from grape residues represent a really interesting pathway. A dedicated and deeper investigation would be needed in order to know operators, volumes and expected income. As for costs, no public data are available for by-products being send for chemical processing, while for cipped prunings used for energy generation the price is in the range of 85-115 €/t (for domestic use). In case of long term contracts with power plants the price can be approx. 70 €/t (it depends on private agreements).

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<sup>5</sup>[https://www.researchgate.net/publication/312578959\\_GRAPE\\_SEED\\_OIL\\_FROM\\_A\\_WINERY\\_WASTE\\_TO\\_A\\_VALUE\\_ADDED\\_COSMETIC\\_PRODUCT-A\\_REVIEW](https://www.researchgate.net/publication/312578959_GRAPE_SEED_OIL_FROM_A_WINERY_WASTE_TO_A_VALUE_ADDED_COSMETIC_PRODUCT-A_REVIEW)


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## 2.6.4 Non-technical barriers

Non-technical barriers may be expected, especially for material converted in bioproducts. In addition, some countries face problems related to plant diseases (i.e. vine yellows), and plant protection and inspection are often ineffective.

Referring energy production, non-technical barriers are similar to the ones describe in the above section 3.2.4 about olive waste.



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## 3 FEED AND FODDER

### 3.1 Profile of the feed and fodder sector

#### 3.1.1 Production of the sector

Animal feed industries final products are homogeneous mixes of several raw materials such as: grains, cereals, vegetable and animal by-products and components like oil and fats, molasses, vitamins and minerals from which a balanced and nutritious food is achieved.

Fodder industries process herbaceous matter for better preservation of the nutritious elements contained on it through three different industrial processes; silage, haymaking and dehydration.

This chapter basically deals with animal feeding. Two different sectors may be defined for this study:

- Feeding of animals used for breeding such as cows, pigs and other edible animals;
- Feeding of pets.

Generally the production of animal feed comes from residues of other agricultural processes, and it is sold in form of pellets. The present food–feed–food system is shown in Figure 9.

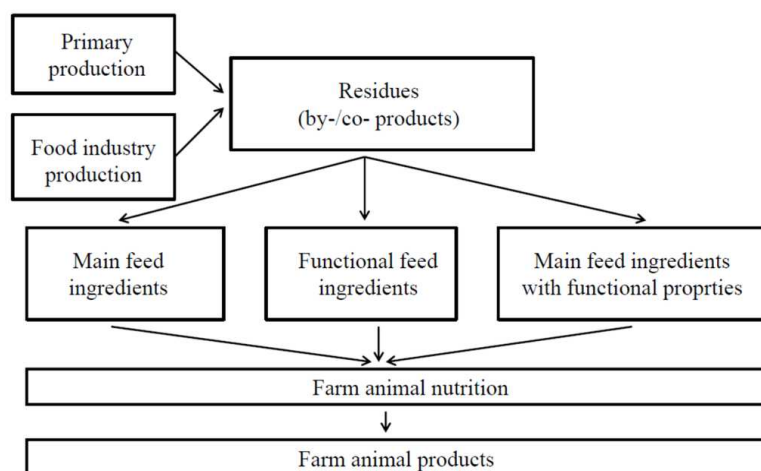



Figure 9. Simplified schematic presentation of the food–feed–food system (source: Agriculture 2015, 5(4), 1020-1034)

Fruit and vegetable industry co-products are collected either from primary production fields, such as in the case of olive leaves, or from the processing factories, such as with pomaces; they are then used either as unprocessed residue or are subjected to processing. Processing procedures may involve drying, since most of these materials have a high moisture content that leads to product spoilage, or they may be subjected to advanced processing/biorefinery techniques for the collection of specific compounds such as phenols, vitamins, fatty acids, or carotenoids. The

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moisture content of olive cake moisture stands around 30%–50% [36], and the average moisture content of grape pomace is approximately 64% (E. Kasapidou 2015).

Thus, residues can not be considered as an important source for an IBLC facility.

### 3.1.2 Volume of the sector

Pig feed, based on maize, cow milk, fish flower and essential amino acids, represents the main output of the sector. Regarding cattle feed, the situation is very contrasted across Europe, depending on the weather conditions for forages production.

The effect of the quota regime, with a +1 % of milk delivery in 2015/16 vs 2014/15, was hardly foreseeable for the compound feed industry EU-wide, with an overall 1 % decrease in industrial cattle feed.

Finally, poultry feed production continued to increase by almost 2 % in 2015, boosted by an increasing per capita consumption of meat, which benefited primarily from poultry meat (+2.5 %).

As a consequence, poultry feed consolidated its position of the leading segment in the EU compound feed production, well ahead of pig feed (Table 13).

*Table 13. Poultry feed production in EU (x 1.000 ton)*

t x 1000	2014	2015
Cattle feed	42.5	42.1
Pig feed	49.2	49.2
Poultry feed	51.8	52.7
Total	155.8	156.1


As for the number of companies it is not possible to present detailed data, since the products are moved to production plants all over Europe and abroad.

### 3.1.3 State of the sector

The sector is sourced with residues coming from other processing sectors, such as straw, sugar beet pulp, protein cake and food residues hence, no significant amount of residues are produced.

Utilization of agroindustrial by-/co-products in farm animal nutrition reduces the environmental impact of the food industry and improves profitability and valorization of the agricultural by-products since feeding food residue to livestock is an efficient way to upgrade low quality materials into high quality foods (Elferink, E.V. et al. 2008).

Figure 10 shows the trend of compound feed in the EU.

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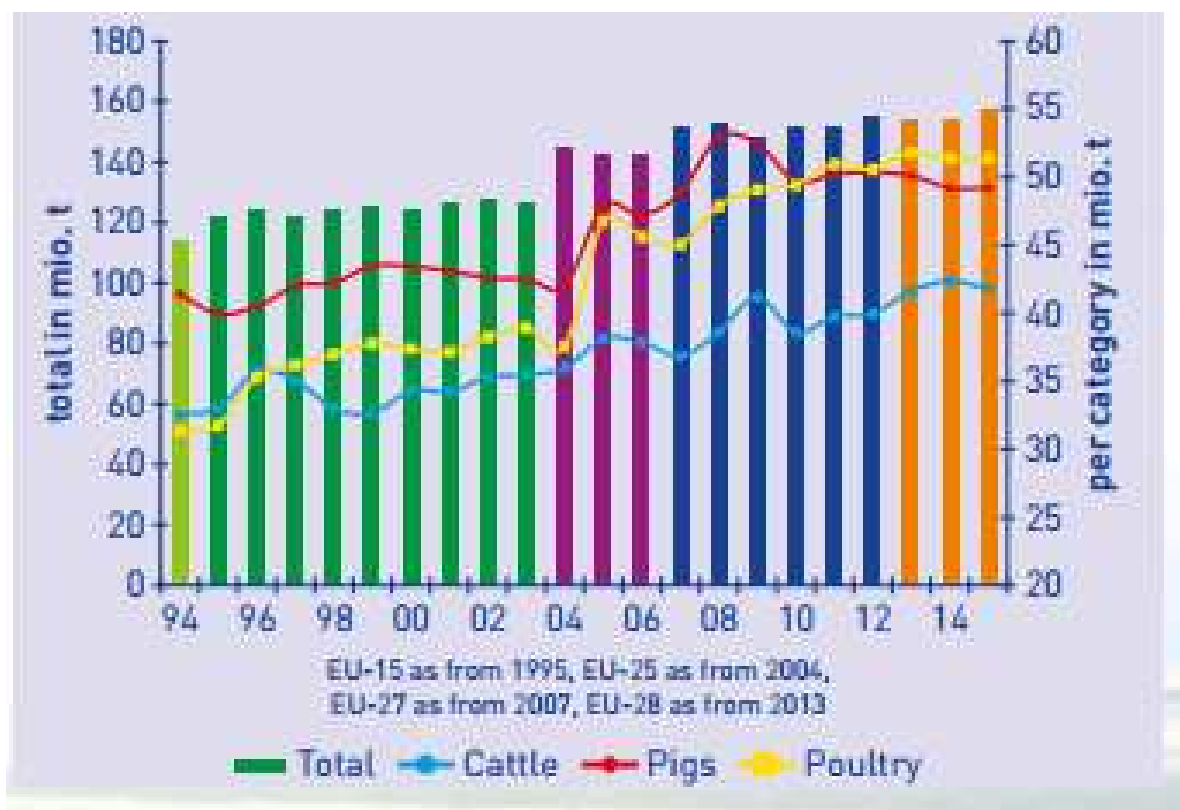


Figure 10. Development of compound feed production in the EU (Source FEFAC)

Despite variations in feed material prices over the last years, the proportion of feed materials per categories remain relatively stable (48 % for cereals, 28 % for oilseed meals). However, this does not reflect significant changes for some feed materials e.g. for corn gluten feed or dried distillers grains, usually imported from the USA, which have almost disappeared since 2007 due to repeated trade disruptions. This was mainly due to asynchronised authorisations of GM crops.

### 3.1.4 Typical size of the companies

The sector is led by large companies that commercialize various products with their brands but who subcontract third parties that produce locally. Contacting specific firms could further analysis these issues.

Table 14 gives an idea of the main food production for animal feeding in Europe (producer associations).

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Table 14 (part A). Main companies operating in Europe and their annual production (Source FeFAC 2015)

National association	Member state	Number of members	National compound feed production (t)				
			Cattle	Pigs	Poultry	Others	Total
Deutscher Verband Tiernahrung e. V. (DVT)	Germany	277	6,700,000	9,646, 000	6,515, 000	909,000	23,770 ,000
Eurofac - La représentation de la nutrition animale Francaise	France	170	5,115,000	4,899,000	8,536,000	1,848,000	20,398,000
Assalzoo - Associazione nazionale fra i produttori di alimenti zootecnici	Italy	100	3,134,000	3,598,000	5,887,000	1,006,000	13,625,000
Nevedi - Nederlandse vereniging diervorederindustrie	Netherlands	100	4,202,000	5,222,000	3,851,000	1,190,000	14,465,000
Bemefa- Apfaca - Association professionnelle des fabricants d'aliments composés pour animax A.S.B.L.	Belgium	124	1,350,000	3,500,000	1,312,000	429,000	6,591,000
AIC - Agriculture industry confederation	United Kindom	106	5,071,000	2,028,000	6,880,000	1,674,000	15,653,000
IGFA - The Irish grain and feed association	Ireland	59	2,573,000	669,000	655,000	108,000	4,005,000


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Table 14 (part B). Main companies operating in Europe and their annual production (Source FeFAC 2015)

National association	Member state	Number of members	National compound feed production (t)				
			Cattle	Pigs	Poultry	Others	Total
Dacofo - The Danish grain and feed association	Denmark	40	880,000	2,330,000	600,000	200,000	4,010,000
Cesfac - Confederacion Española de fabricantes de alimentos compuestos para animales	Spain	223	7,500,000	10,000,000	4,440,000	150,000	22,090,000
IACA - Associacao Portuguesa dos industrias de alimentos compostos para animais	Portugal	57	750,000	800,000	1,430,000	190,000	3,170,000
VFÖ - Verband der Futtermittelindustrie Österreichs	Austria	12	543,000	543,000	601,000	176,000	1,577,000
Lantmännen	Sweden		859,000	338,000	665,000	78,000	1,940,000
FS - Foder & Spannmål	Sweden	60	Confidential	Confidential	Confidential	Confidential	Confidential
FFDIF - Finnish Food and Drink Industries' Federation	Finland	4	677,000	262,000	351,000	115,000	1,405,000
CAFM - Cyprus association of feed manufacturers	Cyprus	24	129,000	33,000	45,000	111,000	318,000
SKK – Commodities and feed association	Czech Republic	42	533,000	765,000	983,000	77,000	2,358,000


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Table 14 (part C). Main companies operating in Europe and their annual production (Source FeFAC 2015)

National association	Member state	Number of members	National compound feed production (t)				
			Cattle	Pigs	Poultry	Others	Total
HGFA - Hungarian grain and feed association	Hungary	94	500,000	1,330,000	1,540,000	130,000	3,500,000
LGPA - Lithuanian grain processors association	Lithuania	35	148,000	36,000	243,000	172,000	599,000
IZP - Izba zbozowuo-passzowa	Poland	56	915,000	1,960 000	6,270 000	605,000	9,750,000
AFPWTC - The association of feed producers, warehouse - keepers and trade companies	Slovenia	36	200,000	224,000	222,000	16,000	662,000
CCIS - Chamber of agricultural and food enterprises	Slovenia	8	83,000	44,000	224,000	16,000	367,000
VFS - Federation of the Swiss compound feed manufactores (not part of EU)	Switzerland	81	504,000	633,000	370,000	48,000	1,555,000



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Table 14 (part D). Main companies operating in Europe and their annual production (Source FeFAC 2015)

CFIA - Grupacija industrije stočne hrane hgh	Croatia	100	136,000	238,000	280,000	10,000	664,000
NFS - Norvegian seafood federation *)	Norway	517	1,005,000	493,000	447,000	19,000	3,692,000
ANFMC – National association of combined feed producers	Romania	50	49,000	1,176,000	1,529,000	2,000	2,756,000

Note for all the Table 14: \*) plus 1 728 000 is for fish breeding

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### 3.1.5 Degree of innovation

The intensification of livestock farming is a solution for land scarcity. This is tied to the improvement of feed efficiency and animal health (related to animal breeding sustainability). The entire technological process of animal feed production can be automatized by introducing computer technology for the precise control and management of the production. In some of the production processes, modern programming can enable the optimization of feed mixtures. Advancements in the field of nutrition of domestic animals, may also create mixtures that meet the most stringent standard requirements.

To foster innovation, an industry-run innovation centre known as the Feed Design Lab was formed by Vitelia, Dinnissen, Imtech, HAS den Bosch and DSM seven years ago. Its R&D programmes focus on feed innovation and ecological sustainability. In the last seven years, the Feed Design Lab has evolved into a vertical partnership of 40 industry stakeholders engaged in feed milling, feed technology, premix making and feed additives.

The discovery of new raw materials (especially proteins) at European level must be highlighted as a contributing factor towards reducing the dependence on raw material imports. Other aspects include the development of new technologies to utilise raw materials more efficiently (e.g. process soya beans not only into feed themselves, but process the whole plant) and better logistics, such as transport. Other issues that are pushing innovation in the sector are environmental concerns that promote the reduction of energy consumption as well as of the use of medicine and antibiotics. The feed industry has a great potential to improve the sustainability of the EU livestock sector and resilience of the food chain by reducing the environmental footprint of livestock by improving feed use and feed conversion rates and through a responsible sourcing, production and use of feed ingredients. The feed industry is engaged with other chain partners to optimise risk management along the feed chain and to develop effective early warning and feed safety management systems, while reducing the need for antibiotics at farm level through advanced knowledge of the impact of feed processing and composition on gut health and use of specific micro-ingredients (FEFAC, FEFANA, 2016).

### 3.1.6 Miscellaneous

Food industry by-products are potential raw materials for animal feeding which inclusion could help to reduce the carbon footprint of the animal feedstuff.

As observed by FEFAC (the main EU organization in the field), the feed industry was able to partially compensate the short-term negative effects of the Russian import embargos. While the compound feed sector has the ability to buffer price volatility for raw materials, livestock farmers and processors still do not make use of hedging tools to lock in prices for livestock products in order to limit the financial risks of price shocks.

European Commission has developed a horizontal methodology, called Product Environmental Footprint (PEF) to measure and communicate in a harmonized way the life cycle environmental performance of products.



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## 3.2 Opportunities IBLC

### 3.2.1 Sector related residues

As described section 5.1.3 no major residues are produced in the feed sector. Feed and fodder facilities are featured by their small or null generation of residues. While the feed industries produce amounts that range between 2 and 10% of their production, fodder dehydration industries do not produce any important biomass residue, either in the agrarian or processing phase (Sucellog, 2017).

The sector is highly suitable for IBLCs due to a good potential in biomass storage and trading.

<b>Production Process</b>	<b>Waste and by-Products (%)</b>
White wine production	20–30
Red wine production	20–30
Fruit and vegetable juice production	30–50
Fruit and vegetable processing and preservation	5–30
Vegetable oil production	40–70
Sugar production from sugar beet	85

Figure 11. Percentage of food wastes and by-products in fruit and vegetable production (source: Agriculture 2015, 5(4), 1020-1034)

Fruit and vegetable processing co-products still remain an underexploited source for the dietary supplementation of farm animals with functional compounds and the production of valueadded products. Commercial application of fruit and vegetable industry co-products as functional feed ingredients provides challenges and opportunities for new researches and busnises.

However, waste from feed and fodder can also be used for biogas production. But detailed analyses on local conditions are always needed because for the plant efficiency a combination with solid biomass from agroindustry residues is requested.


### 3.2.2 Potential synergies & benefits

As discussed in section 5.1.5, new technological developments in Europe are providing new sources of raw materials (especially proteins). The most important synergies within this sector seems to be the capacity of storage of non-fooder material.

The feed sector benefits from a strong synergy with the other sectors. It acts as a storage facility allowing intermediate ground for biomass exchange and works as a IBLC.

### 3.2.3 Market developments

From an IBLC point of view, only storage yards are considered as a potential market development as reported in the previous paragraph. Unfortunately, due to confidentiality of industrial information, there is no reliable data available for the EU to date.


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### 3.2.4 Non-technical barriers

The use of additives in the manufacture of compound animal foods can hamper acceptance, because it could cause unexpected problems i.e. allergies, intollerances, other negative effects. The use of food supplements in this field is strictly controlled by the local national authorities. Thus, generally the acceptance of the material does not require deeper analysis (although sample controls are done by the responsible authorities). In addition, as described above, the increase of food production efficiency can foster societal acceptance. This often results in new product lines (e.g. the increasing popularity of “slow-growing chickens”).

In some countries, i.e. Spain, the legislative barrier that concerns these industries is the mandatory disposal of their residues by an authorized manager, reducing chances of using those for any biomass purposes.

Thus, at European level, there are only few non-technical barriers foreseen for the food sector and no evidence of any non-technical barrier regarding the fodder industries that could impede the development of an IBLC.

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## GRAIN CHAIN

### 3.3 Profile of the grain chain sector

#### 3.3.1 Production and volume of the sector

The EU is not self-sufficient in terms of cereals. Thus, cereals have to be considered as commodities. The species to be taken into account are:

- Wheat (both *T. durum* and *T. aestivum*);
- Barley;
- Maize;
- Other minor cereals as rye, oats and triticale.


In addition, rice plays a key role for residues production.

The production of cereals (including rice) in the EU-28 was around 301 million tonnes in 2016. This represented about 12.5 % of global cereal production.

Common wheat and spelt, barley, grain maize and corn-cob-mix (CCM) accounted for a high share (86 % in 2015) of the cereals produced in the EU-28. Compared to the five-year average level, EU-28 cereal production increased by 5.7 %. An increase was recorded for common wheat and spelt (13.8 %), and barley (10,3 %), while grain maize and CCM production decreased by about 11.2 % (minus 23.1 % compared with 2014) (Eurostat 2017). This was mainly due to one of the warmest summers ever recorded in south-Eastern Europe. Rye and winter cereal mixtures production accounted 7.1 % below the 5-year average. The production of oats decreased by 3.8 %.

France accounted for more than one fifth (22.9 %) of the EU-28 cereal production in 2015. Germany (15.4 %) and Poland (8.8 %) together contributed to a quarter of the EU total. The United Kingdom was the next largest cereal producer, accounting for 7.8 % of the EU-28 total. Among the EU Member States, France was the largest producer of common wheat, barley and grain maize, and CCM, in 2015.


Table 15 reports the cereal surface in EU.

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*Table 15. EU area for cereals production (source: DG Agri; millions of ha)*

	2014	2015	2016
Soft wheat	24.4	24.3	24.2
Durum wheat	2.3	2.5	2.7
Barley	12.4	12.2	12.3
Maize	9.6	9.2	8.5
Rye	2.1	2.0	2.1
Oats	2.5	2.5	2.6
<b>Total</b>	<b>58.1</b>	<b>57.3</b>	<b>56.9</b>

Figure 12 reports the distribution of the surface cultivated with cereals in each EU Member State in 2016.

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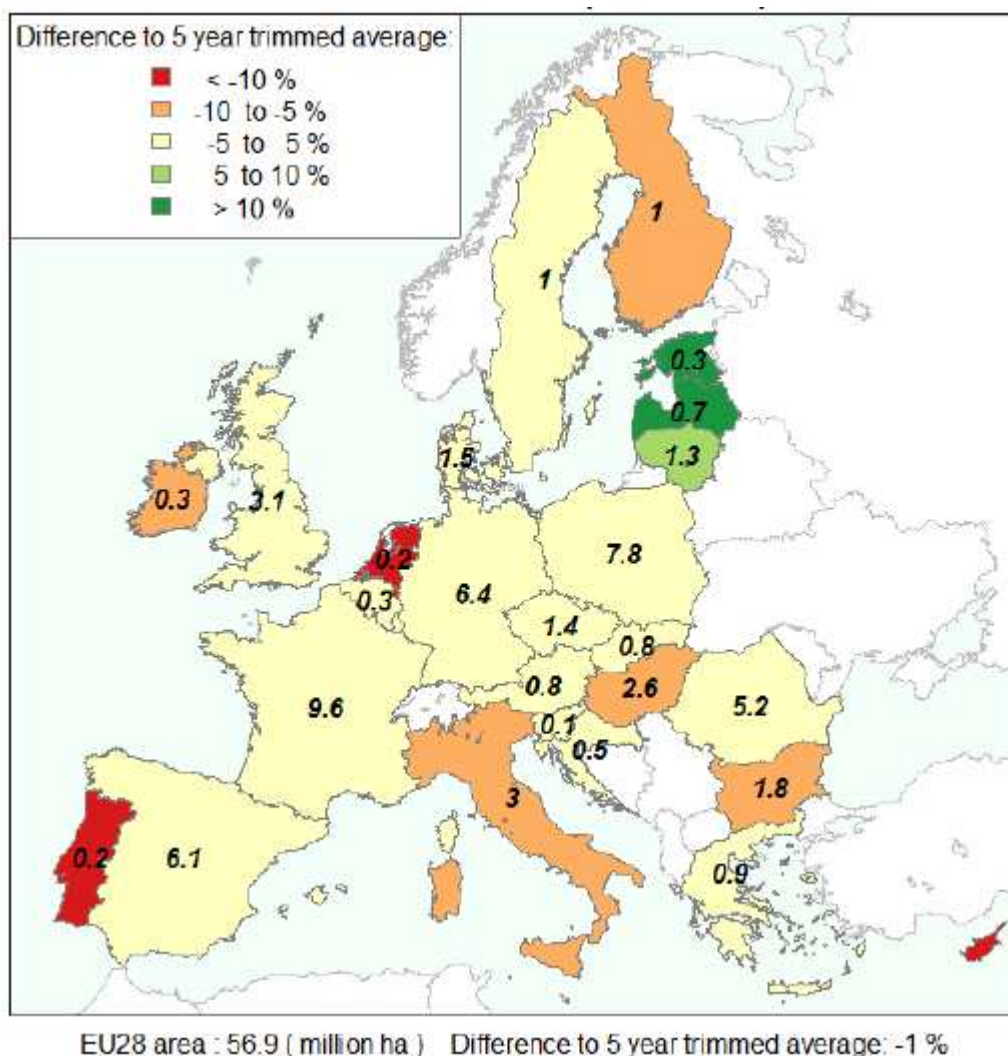




Figure 12. Cereal surface per Member State (2016; source DG Agri)

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As for the usable production, Table 16 shows the proper data.

*Table 16. Usable production of cereals in EU (Millions of t; source: DG Agri)*

	2014/2015	2015/2016	2016/2017	Change 2015/2016
Soft wheat	148.7	151.3	134.1	-11.4
Durum wheat	7.6	8.3	8.9	7.2
Barley	60.2	61.4	59.3	-3.4
Maize	77.9	59.1	60.2	1.9
Rye	8.7	7.6	7.9	3.9
Oats	7.7	7.5	8.1	8.0
<b>Total</b>	<b>329.2</b>	<b>311.6</b>	<b>294.6</b>	<b>-5.5</b>

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The main rice producers are Italy and Spain. Tables 17 and 18 show surface and production of rice.

*Table 17. Surface cultivated with rice, most important countries (x 1.000 ha; source: Eurostat)*

	2010	2011	2012	2013	2014	2015	2016
<b>European Union</b>	<b>473.70</b>	<b>483.10</b>	<b>454.15</b>	<b>432.94</b>	<b>432.27</b>	<b>443.33</b>	<b>441.80</b>
Bulgaria	11.97	11.79	9.90	10.21	11.04	12.41	11.99
Greece	34.02	32.39	30.21	29.10	30.72	35.08	35.18
Spain	122.18	122.37	112.82	112.15	110.42	109.29	109.33
France	23.55	23.18	20.73	20.71	16.68	16.17	16.78
Italy	238.46	246.55	235.05	216.02	219.53	227.33	227.33
Portugal	29.12	31.44	31.17	30.18	28.75	29.14	29.14
Romania	12.40	12.67	11.30	11.93	12.72	11.11	9.11

*Table 18. Rice production in EU, most important countries (x 1.000 t; source: Eurostat)*

	2010	2011	2012	2013	2014	2015	2016
<b>European Union</b>	<b>3,230.76</b>	<b>3,122.90</b>	<b>3,127.79</b>	<b>2,921.34</b>	<b>2,852.73</b>	<b>2,995.44</b>	<b>Not available</b>
Bulgaria	57.43	59.62	54.90	56.12	54.16	67.68	64.72
Greece	229.49	254.99	215.52	239.49	229.90	251.15	266.15
Spain	927.82	927.55	899.60	876.63	861.10	847.03	821.46
France	115.05	130.40	123.22	80.86	83.41	80.86	80.64
Italy	1,671.82	1,497.04	1,594.48	1,433.11	1,415.73	1,518.25	1,518.29
Portugal	170.22	185.02	187.03	180.16	167.32	184.92	166.43
Romania	61.59	65.26	50.86	54.65	45.16	49.77	42.55

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### 3.3.2 State of the sector

As described above, cereals are considered as “commodities”. Thus, the economic figures depend on the market conjuncture. As for the cereal price, the main reference is the Rotterdam port. Further, the Commission gives aggregated data and forecasts (Figure 13). Price fluctuation depends on factors such as geopolitical situation, embargoes, climate, etc.

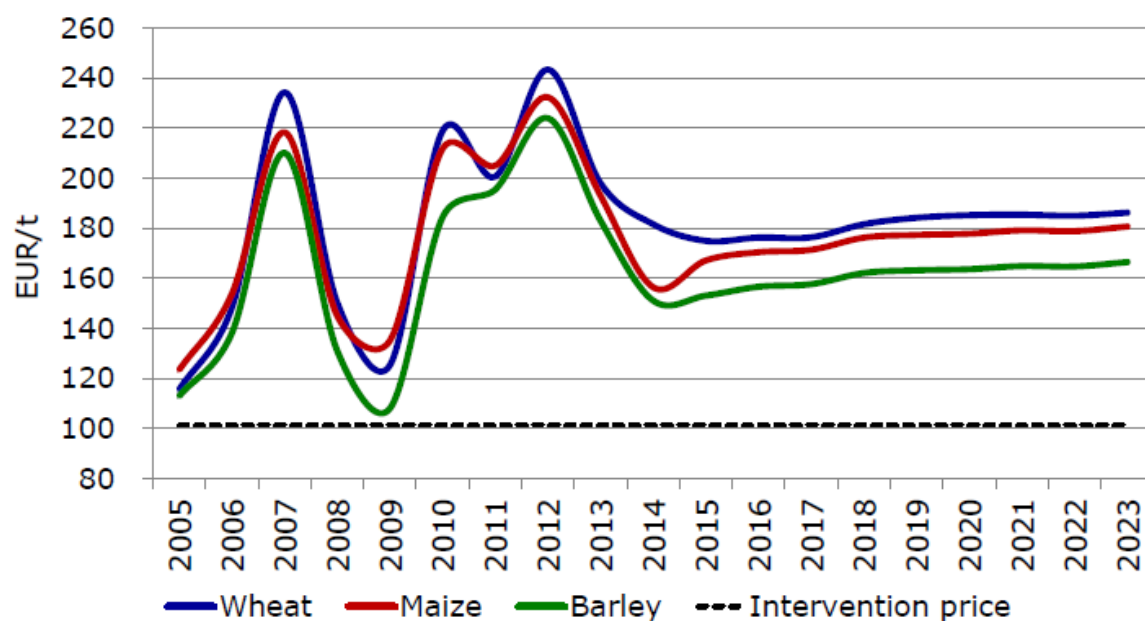



Figure 13. EU cereal prices above historical averages over the medium term (source: EU commission; €/t)

Another relevant factor is the climatology, especially concerning the annual rain regime, with high variability between the drought seasons productions and the rest. This also affects the availability of several residues such as straw.

For instance, dry season cowpea grain and fodder become available in late April/early May when prices peak and farmers are able to make a high profit. Similarly, cowpea fodder prices in the dry season were three times higher than the price of fodder in the early rainy season (CGIAR).

The recovery costs for straw plus the nutrient value inherent in the straw can be regarded as the minimum price of straw. The idea behind this approach is that, generally, leaving cereal straw on the fields constitutes the best alternative use of straw. The actual long-term value of this practice is difficult to measure, but the value of the nutrients contained within the straw can be directly calculated using market prices for these nutrients. Therefore, the minimum price for straw is the price that will at least compensate the farmer for the foregone nutrients (BIOCORE FP7 project, 2012).



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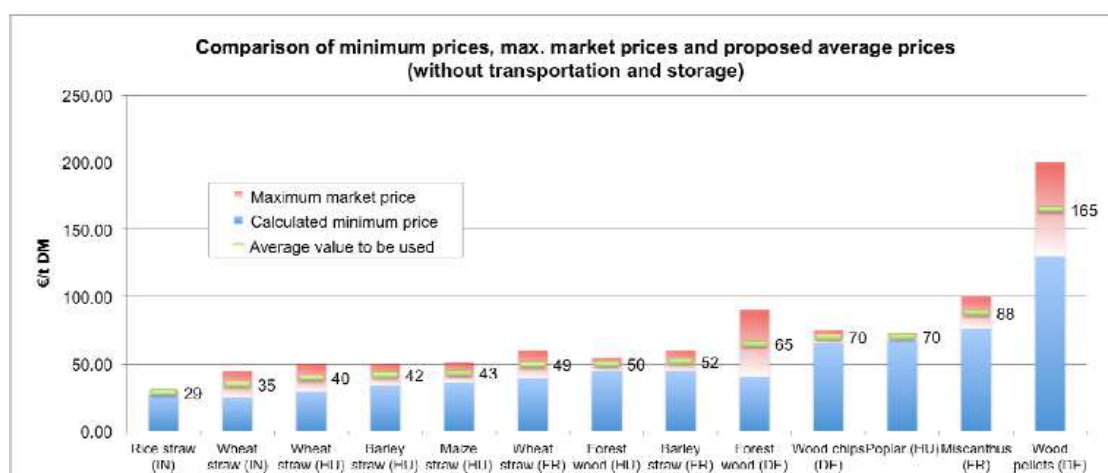


Figure 14. Comparison of minimum prices, maximum market prices and proposed average prices (Source: NOVA, 2012)

### 3.3.3 Typical size of the companies

In Europe the sector is represented by numerous small mills that operate also for large brands (i.e. Bunge or Cargill). As an example, in Ukraine the majors producers for wheat and corn producing between 50.1 – 200 tonnes per year while the barley production is dominated by small agricultural producers. The most numerous categories are the ones with gross yearly production between 10.1-20 tonnes, 20.1-50 tonnes and 50.1-200 tonnes (The State Statistics Service of Ukraine, 2015).

A new consumer trend of “local and small scale” production is on the rise and should be noted. Thus, a local analysis may be useful to understand which facilities could act as IBLC.

### 3.3.4 Degree of innovation


Technology is well consolidated and improvements may target grain drying efficiency. new technologies are needed to enhance quality, reduce energy consumption, improve safety and reduce environmental impact. As examples of emerging drying technologies include: heat-pump-assisted drying, microwave-assisted drying, low pressure superheated steam drying, pulse combustion spray drying, pulsed and ultrasound-assisted osmotic dehydration as well as novel gasparticle contactors such as impinging streams and pulsed fluidized beds (A. S. Mujumdar, S.V. Jangam, 2015).

However, innovation is clearly influenced by the size of companies, with large variations between the innovation effort of big players and the small ones mainly related the costs of investments.

## 3.4 Opportunities IBLC

### 3.4.1 Sector related residues

The grain sector generates a variety of residues and by-products, which can be used directly as feedstock for biomass production or pre-processed into secondary products. Residues are produced in all stages of the grain chain. Among the primary residues are for example wheat straw,

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corn stems, sunflower husks etc. These represent a cheap and rich in lignocellulose feedstock for bioenergy generation.

The milling process of wheat produces large amount of wheat bran and germ as a byproduct. During milling, the endosperm is broken down into fine particles (white flour) while bran and germ are removed. Wheat is a significant agricultural and dietary commodity worldwide with known antioxidant properties concentrated mostly in the bran. Wheat germ, being a byproduct of the flour milling industry, is considered a natural source of highly concentrated nutrients at a relative low cost (Y.Y. Tsadik 2015).


Most cereal grains are delivered to mills clean from residues. Rice hulls seem to be the only useful by-products. In fact, rice is generally delivered in form of paddy rice, with husks. The refining process aims to separate husks from the grain, in order to obtain an edible grain. Unfortunately, rice husks residues (glumellae) presents some problems in burning (due to its silicious content that improves ash production). In addition, the melting point of such material compromises the burning performances. Other uses (such as fermentation) should be investigated. Taking into account that the rice husk represents 17-23 % of grain weight (depending on the cultivar), the estimation reported in Table 19 could be considered as representative.

*Table 19. Estimation of rice residues for the most important countries (x 1.000 t)*

	Processing residues (t)
<b>European Union</b>	59,908.80
Bulgaria	1,353.60
Greece	5,023.00
Spain	16,940.60
France	1,617.20
Italy	30,365.00
Portugal	3,698.40
Romania	995.40

Straw can be considered as a residue and it is already used in the animal feeding and animal bedding sector. Due to the structure of its market, in which the larger industries are not involved, it does not presents an opportunity for IBLC at present.

Maize processing industries have also several unexploited residues such as the corn cob, leaves or stalks that could be potentially valorised both for bio-energy and the manufacture of bio-commodities purposes.

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Corn is processed using a wet milling procedure to produce several important products. The most abundant of these is starch, which is further processed to generate sweeteners used mostly in soft drinks. In addition, oil is also separated from the corn in this process. One hundred pounds of dry corn produces 67 pounds of starch and sweeteners, 3.6 pounds of oil, and 29.4 pounds of byproducts or coproducts. The byproducts consist of the bran (seed coat), germ (center of the grain), gluten (high protein component of corn flour), and other solids (extractives). Major byproducts are corn gluten feed and corn gluten meal (M. Wahlberg, 1999).

### 3.4.2 Potential synergies & benefits


A lot of biomass fuels are available as by-product from agricultural crop production including grain chains. There is an interesting amount of rice residues that can be used in an IBLC framework. Rice husk is the most prolific agricultural residue in rice producing countries around the world. It is one of the major by-products from the rice milling process and constitutes about 20% of paddy by weight. Rice husk, which consists mainly of lingo-cellulose and silica, is not utilized to any significant extent and has great potential as an energy source (S. Zafar, 2015).

Spain and Italy may especially contribute in terms of rice husks, although further updated technologies have to be set up. On the other hand, this sector is able to concentrate a large amount of biomass. Unfortunately, facilities are spread over the territory, and valuable contacts are needed among the producers to achieve details about products and quantities. Especially for rice residues, the collocation on a new European market should improve the business model of the companies involved also to be competitive at national level. New technologies may play a key-role.

The benefits of using rice husk technology are numerous. Primarily, it provides electricity and serves as a way to dispose of agricultural waste. In addition, steam, a byproduct of power generation, can be used for paddy drying applications, thereby increasing local incomes and reducing the need to import fossil fuels. The by-products are fly ash and bottom ash, which have an economic value and could be used in cement and/or brick manufacturing, construction of roads and embankments, etc. (S. Zafar, 2015).

### 3.4.3 Market developments

Agriculture is an important part of the economy in all of the EU member countries. Together with the specific crops, large quantities of residues are generated every year. Rice, wheat, sugar cane, maize (corn), soybeans and groundnuts are just a few examples of crops that generate considerable amounts of residues. These residues can constitute a relevant part of the total annual production of biomass and they could be an important source of energy both for domestic and industrial purposes.

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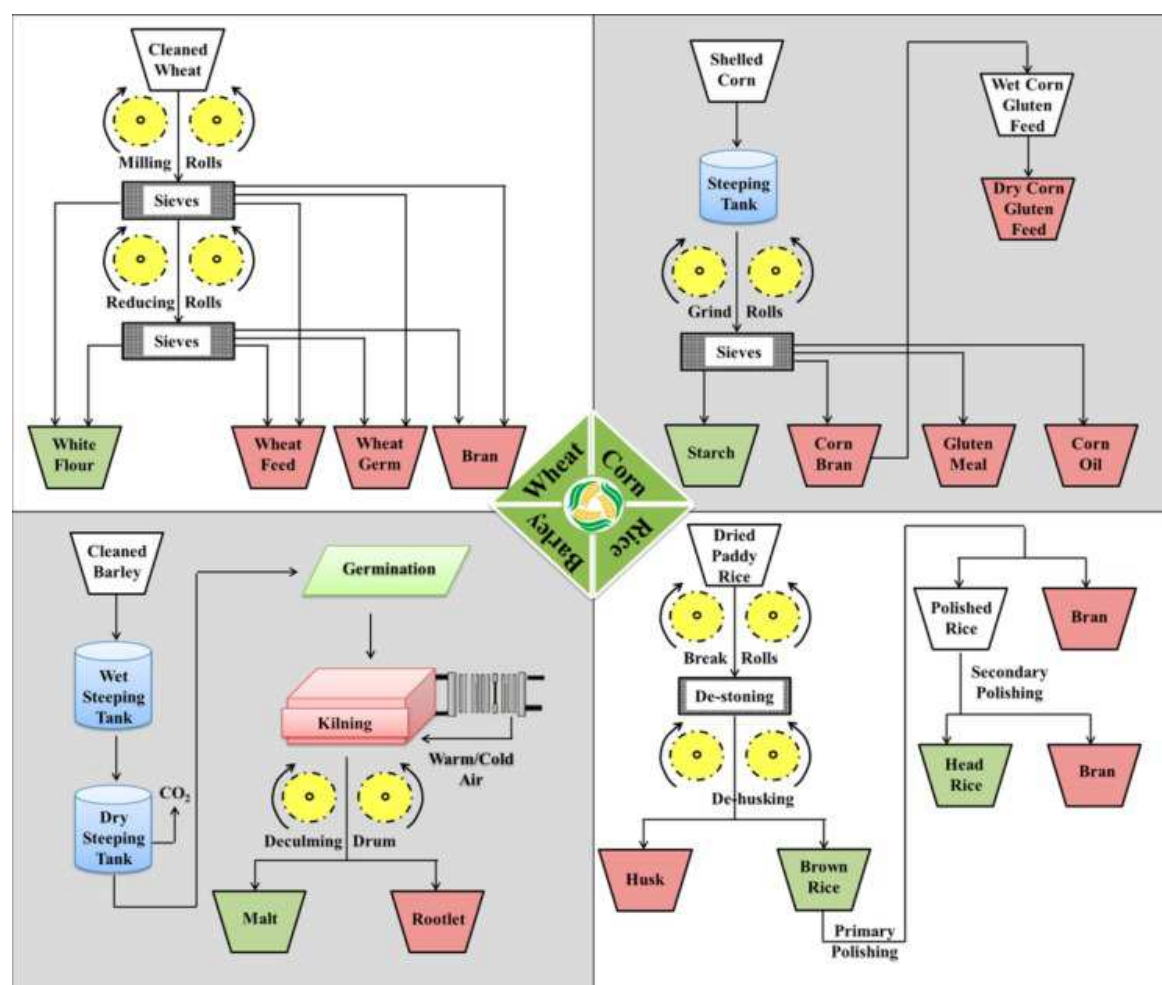



Figure 15. Schematic diagram of the main industrial processing of cereals illustrating products (green shade) and some byproducts (red shade) (Source: US National Library of Medicine, 2013<sup>6</sup>)

As already explained in the previous section 6.2.1, technical barriers occur in the use of some by-products for instance corn cob or rice husk – glumellae. Specifically, a lot of ash is produced which affects burner performance and life. Evidence suggests that there is potential for bioproduct production, however, there is no specific information publicly available.

### 3.4.4 Non-technical barriers


Relevant non-technical barriers are not foreseen due to the particular environment friendly characteristics and potential of the sector residues as reported in the previous sections. Only smell coming from drying processes could become a disturbance to the local community. However, with the right equipment (such as post-burners or other uses by fermentation) this issue can be overcome. Supportive national environmental policies permit this material to be considered as

<sup>6</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3774676/>

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secondary raw material instead of waste. This is also encouraged by the EU circular economy strategy.

Another non-technical barrier is represented by the high investments costs for biomass processing that could represent in many cases a significant financial barrier for many companies.

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## 4 SUGAR INDUSTRY

### 4.1 Profile of the sugar industry sector

#### 4.1.1 Production and volume of the sector

The EU is the world's leading producer of beet sugar, with around 50 % of the total, but beet sugar represents only 20 % of the world's sugar production while the other 80 % come from sugar cane. Most of the EU's sugar beet is grown in Northern Europe, where the climate is more suited to growing beet. The most competitive producing areas are in northern France, Germany, the United Kingdom and Poland. The EU also has an important refining industry that processes imported raw cane sugar.


EU sugar production in 2015/16 was lower than the years before (see Table 20). This reduction in supply came in the context of an unprecedented period of low prices and an abundant supply of quota sugar resulting from large quantities carried forward from 2014/15. Fresh EU production for 2015/16 amounted to 14.7 million tonnes, down 22.9 % compared to 2014/15.

The exceptional harvest in 2014 (13 % above the 5-year average) led to almost 3 million tonnes of out-of-quota sugar being carried forward to 2015, to be counted as quota sugar in the following season. This meant that about 22 % of the quota sugar for 2015 de facto had been produced before the season started. This led to a strong incentive for sugar producers to reduce sugar output significantly in 2015 (DG AGRI 2015). A combination of a reduction in sown area and unfavourable summer conditions led to a 22 % reduction in sugar beet production compared to 2014, which was 12 % below the 5-year average.

In 2015, the EU-28 produced 101.9 million tonnes of sugar beet - 29.2 million tonnes less than in 2014 (see Figure 5). More than half of the EU-28 sugar beet production in 2015 came from France (32.9 %) and Germany (22.2 %) Poland (9.2 %) and the United Kingdom (6.1 %) being the next largest producers. Table 20 shows the European surface cultivated with sugar beet, while Table 21 shows productions.

Table 20. EU surface cultivated with sugar beet; most important countries (source: Eurostat; x 1.000 ha)

	2010	2011	2012	2013	2014	2015	2016	2017
<b>European Union</b>	:	<b>1,624.54</b>	<b>1,637.70</b>	<b>1,557.95</b>	<b>1,632.40</b>	<b>1,420.32</b>	<b>1,505.22</b>	:
Belgium	:	62.20	61.20	59.80	58.60	52.35	55.50	63.70
Czech Republic	56.39	58.33	61.16	62.40	62.96	57.61	60.74	66.10
Denmark	39.20	40.00	40.80	38.00	38.00	36.00	33.10	36.00
Germany	364.12	398.10	402.10	357.40	372.50	312.80	334.50	403.80
Greece	13.20	5.51	8.05	5.81	7.87	5.18	4.99	5.24
Spain	43.38	44.93	38.95	32.05	38.41	37.61	32.91	36.62
France	383.76	393.13	389.79	393.63	406.74	385.05	405.23	471.87
Croatia	23.83	21.72	23.50	20.25	21.90	13.88	15.30	20.00

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Italy	62.67	62.24	45.55	40.71	51.99	38.12	38.12	38.12
Lithuania	15.30	17.60	19.20	17.70	17.00	12.24	15.24	16.00
Hungary	13.86	15.15	18.72	18.82	15.42	15.51	15.94	16.02
Netherlands	70.56	73.33	73.00	73.00	75.00	58.43	70.60	85.40
Austria	44.84	46.58	49.26	50.85	50.60	45.44	43.50	42.89
Poland	206.40	203.50	212.00	193.70	197.60	180.10	205.57	:
Romania	22.03	18.82	27.30	28.14	31.28	26.59	24.21	26.33
Slovakia	17.93	18.10	19.74	20.33	22.21	21.52	21.48	22.22
Finland	14.60	14.10	11.50	12.00	13.70	12.40	11.60	11.90
Sweden	37.95	39.60	39.00	36.23	34.26	19.38	30.60	31.08
United Kingdom	118.00	113.00	120.00	117.00	116.00	90.00	86.00	91.00
Serbia	70.97	59.22	69.07	66.53	64.11	42.12	49.24	
Ukraine	27.9	36.3	41.1	39.9	47.7	43.6	48.2	

Table 21. EU production of sugar beet; most important countries (source: Eurostat; x 1.000 t)

	2010	2011	2012	2013	2014	2015	2016	2017
European Union	:	1,624.54	1,637.70	1,557.95	1,632.40	1,420.32	1,505.22	:
Belgium	:	62.20	61.20	59.80	58.60	52.35	55.50	63.70
Czech Republic	56.39	58.33	61.16	62.40	62.96	57.61	60.74	66.10
Denmark	39.20	40.00	40.80	38.00	38.00	36.00	33.10	36.00
Germany	364.12	398.10	402.10	357.40	372.50	312.80	334.50	403.80
Greece	13.20	5.51	8.05	5.81	7.87	5.18	4.99	5.24
Spain	43.38	44.93	38.95	32.05	38.41	37.61	32.91	36.62
France	383.76	393.13	389.79	393.63	406.74	385.05	405.23	471.87
Croatia	23.83	21.72	23.50	20.25	21.90	13.88	15.30	20.00
Italy	62.67	62.24	45.55	40.71	51.99	38.12	38.12	38.12
Lithuania	15.30	17.60	19.20	17.70	17.00	12.24	15.24	16.00
Hungary	13.86	15.15	18.72	18.82	15.42	15.51	15.94	16.02
Netherlands	70.56	73.33	73.00	73.00	75.00	58.43	70.60	85.40
Austria	44.84	46.58	49.26	50.85	50.60	45.44	43.50	42.89
Poland	206.40	203.50	212.00	193.70	197.60	180.10	205.57	:
Romania	22.03	18.82	27.30	28.14	31.28	26.59	24.21	26.33
Slovakia	17.93	18.10	19.74	20.33	22.21	21.52	21.48	22.22
Finland	14.60	14.10	11.50	12.00	13.70	12.40	11.60	11.90
Sweden	37.95	39.60	39.00	36.23	34.26	19.38	30.60	31.08
United Kingdom	118.00	113.00	120.00	117.00	116.00	90.00	86.00	91.00
Ukraine	13.79	18.74	18.43	10.78	15.73	10.33	14.01	

#### 4.1.2 State of the sector

The EU was the world's leading producer of sugar beet (around 50 % of the total). The EU 28 produces on average close to 20 million tonnes of white sugar per year, from around 2 million

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hectares. Sugar beet seed is produced on approximately 9.000 hectares, mostly in France. Further info on the sugar market can be found under the DG Agri of the Commission.

The EU Seed Marketing Directive for beet seed (2002/54) and the Reforming the European Union's sugar policy are the legal and regulatory basis to be taken into account.

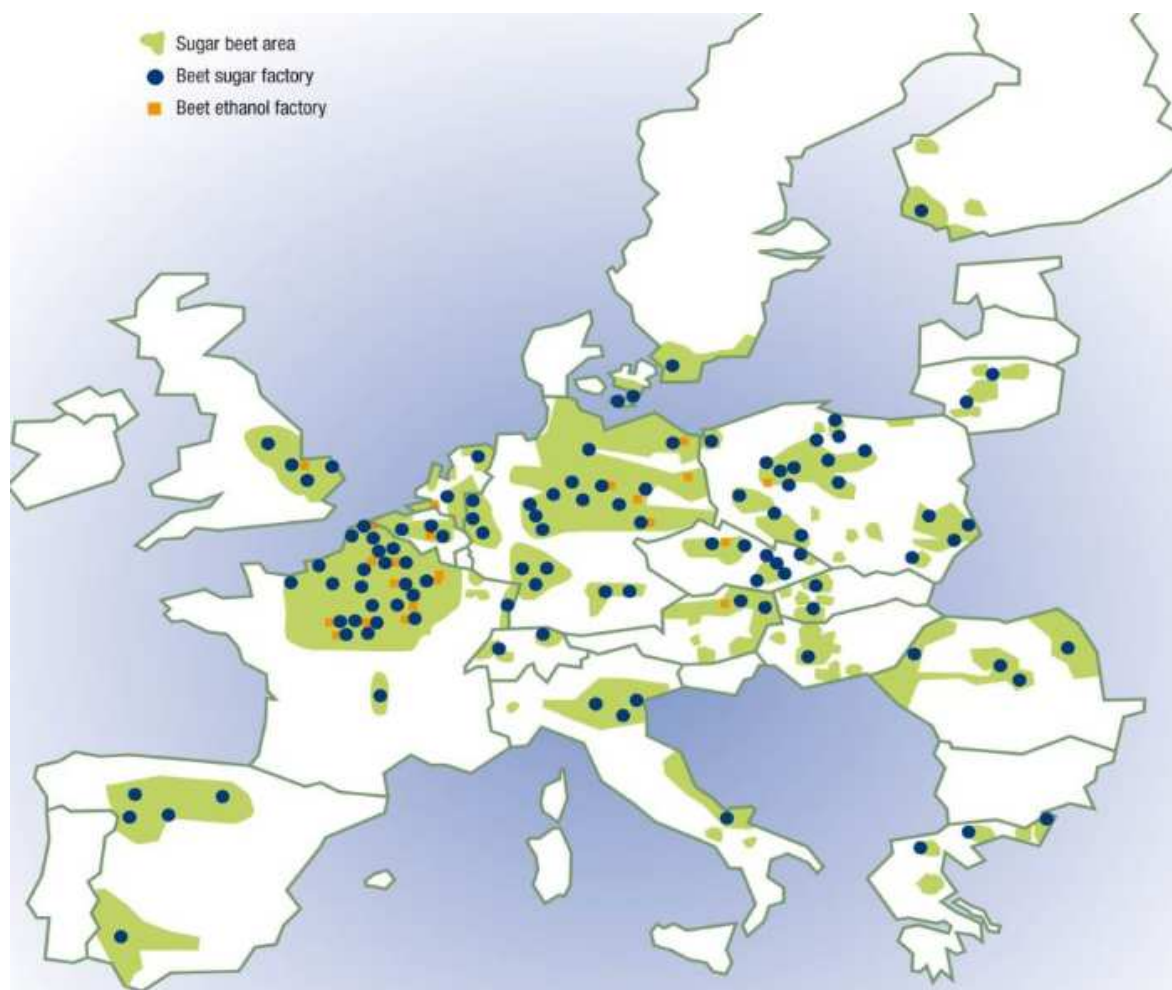
In 2006 a major reform achieved simplification and greater market orientation of the EU's sugar policy, which is now part of the Single Common Market Organisation (CMO). Income support for sugar beet farmers has been integrated into the direct payment system. EU sugar policy today concerns three main areas: quota management, a reference price and a minimum guaranteed price to growers, and trade measures. The quota management ended on 30 September 2017. With regards to volumes of sugar in the UE and worldwide, there has been a shift from global oversupply in the sugar market to a period where consumption is greater than production, which has led to strong price increases on the world market. Within this new global market situation the expiring of the sugar and isoglucose quotas in 2017 will have a profound impact on the EU sweetener market. Despite lower domestic prices, EU production is expected to increase significantly in the first post-quota years.

It is not easy to identify facilities with potential as IBLC due to the sub-contracting of production to small local companies that can be seen in almost all the European sugar producing countries. To go on-field would be necessary to verify real interest and potential.

Figure 16 gives an European figures of the sector.



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*Note: Please consider that some facilities have been cut down with the new reform of sugar market*

*Figure 16. Sugar beet sector in Europe (source: <http://www.cibe-europe.eu>)*

### 4.1.3 Typical size of the companies

The structure of companies in the sugar industry is dominated by medium and large companies because the equipment needed in the sugar industry is better suited for larger facilities. The Hellenic Sugar Industry SA is the only sugar producer in Greece while in Ukraine, over the last years agricultural holding companies big producers have pushed small and medium size producers aside, controlling about 80% of the sugar market.

It is quite difficult to have official data about this sector, due to the sub-contractor agreements with brand companies that makes not easy to collect information from each local producer.

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#### 4.1.4 Degree of innovation

Sector innovation is focused on reducing the energy input by improving efficiencies and adopting renewable energies.

Sugarcane can be used to develop multiple forms of energy, including ethanol, bioelectricity and biohydrocarbons. Probably the most recognized is sugarcane ethanol which reduces greenhouse gas emissions by 90 percent on average compared to gasoline. Sugarcane mills can be energy self-sufficient burning leftover stalks and leaves in boilers to produce enough bioelectricity to power their operations with also the possibility to sell energy back to the grid. Producers can also obtain carbon credits from bioelectricity project. (sugarcane.org).

To produce biomethane from sugarcane residues and use it in diesel engines in farm machinery is another possibility for the sector.

Greece and other countries are conducting research aiming at creating the appropriate genetic material, include the endurance to biotic and abiotic factors, the upgraded quality and the optimum productive potential.

Other innovative technologies involve material elements such as equipment to control pollution and measurement instruments, as well as operating methods, such as waste management practices and guidelines to create responsible approaches on the project of products, manufacture, environmental management, etc.

Enhancing technology innovation and adoption in the sugar industry will allow for new products and applications within the industrial biotechnology and biofuels sector generating market opportunities structured around global value chains.


## 4.2 Opportunities IBLC

### 4.2.1 Sector related residues

Sugar residues from sugar beets are mainly used for animal feeding and bioenergy production. Harvesting residues, namely beet top, are generally ploughed in the soil. Hence, the most interesting residues come from the sugar extraction process. During processing, solid residues (25-30 % of the input) are turned into "bagasse" and sugar beet vinasse. These are mostly used for steam generation, commonly in the same refining facility.

Other residues include sugar beet pulp, suitable for biogas production by means of anaerobic digestion and molasses that can be used as feedstock for bioethanol. However, this type of production is not widespread because sugar beet pulp deteriorates very fast requiring rapid transportation to biogas production facilities.

Other uses of sugar beet residues include animal feed and cellulose for paper mix production. Potential opportunities can also be found in bioplastics, and polymers production. An example comes from the PHBottle project that has created a prototype bottle from sugars recovered from

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wastewater used in the juice industry, making what it calls “active bio-based packaging”. The project partners claim that 30% of the sugars from juice industry wastewater can be recovered and re-used. The bottle is made from polyhydroxybutyrate (PHB), a polymer produced by bioproduction (microbial fermentation) in which certain bacteria use the sugars in the wastewater and synthesise this type of bioplastic. The project, coordinated by Ainia, has been working to exemplify the “circular economy” concept promoted by the EU in its commitment for innovation and sustainable technological development, under the 7th Framework Programme (J. Snodgrass, 2016).

## 4.2.2 Potential synergies & benefits

Potential synergies are mainly related to animal food market using sugar residues as feed. However, new bioproduct production technologies may offer new synergies and related markets, as described in the previous 4.2.1.


## 4.2.3 Market developments

Residues of processing already have their own market for all the main producers, mainly in animal feeding and food industry. Although new market or alternative uses can be seen in the renewable energy production. Nevertheless, new technologies for bioproduct production may open new market opportunities.

## 4.2.4 Non-technical barriers

The abolition of the sugar production quota in the European Union will affect sugar beet producers in many countries. From 2006-2010, the EU sugar sector underwent a significant reform, which saw a system of voluntary compensation (worth EUR 5.4 billion) finance a significant restructuring of the sector, reducing production by roughly 6 million tonnes with the closure of roughly 80 sugar beet processing factories, including the end of production in a number of Member States. The 2013 CAP Reform saw Member States and the European Parliament reach agreement on the abolition of sugar quotas at the end of the 2016/17 marketing year, i.e. from 30 September 2017 (EC DG Agri, 2016).

In countries like Serbia, problems appear due to the unresolved relationship and poor leasing conditions of state land. In this case, short timeframes for the leasing of land (for periods of just a year) limit yields and make crop rotation difficult. In such conditions, disease build-up and soil contamination with residual herbicides and chemicals affects yield and quality of sugar beet crops.

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## FOOD PROCESSING INDUSTRY

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### 4.3 Profile of the food processing industry sector

#### 4.3.1 Production and volume of the sector

Europe's food and drink industry plays a key role in terms of turnover, value added and employment. The food and drink industry also accounts for more than 285,000 SMEs that generate almost 50 % of the food and drink industry turnover and value added and provide 2/3 of the employment of the sector (FoodDrink Europe, 2016). The sector is mainly characterized by the production of:

- Deep-freezed food;
- Fresh food;
- Pre-cooked food;
- Drinking product such as soft drink, beer and wine.

The EU food and drink industry is competitive on a global scale and produces high quality, healthy and safe food. Still, in recent years, the sector is facing a decrease in its relative competitiveness compared to other world food producers, mostly in terms of slower growth in labour productivity and added value. Certain problems have been observed in the functioning of the EU food supply chain linked to transparency, sub-optimal business-to-business relationships, a lack of attractiveness for skilled workers and low market integration across EU countries. Table 22 gives a figure of the EU situation.


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Table 22 (part A). Food and drink industry data (source FoodDrinkEurope National Federations; 2014)

	Employment ranking in manifauactoring	Turnover (Billion of €)	Value added (Billion of €)	Number of employers (x 1.000)	Number of companies
Austria	-	22	5.1	82.6	3,872
Belgium	1	48	7.6	88.5	4,532
Bulgaria	2	4.9	0.9	94.7	5,963
Croatia	1	5.1	4.7	31.7	2,970
Czech Republic	4	11.6	1.9	92.4	7,538
Denmark	2	25.8	4.3	44.8	1,589
Estonia	2	1.9	0.4	15.1	525
Finland	3	11.2	2.7	38	1,700
France	1	184.5	36.2	619.5	62,225
Germany	2	172.2	35.2	559.8	5,828
Greece	1	14.5	2	86.4	1,330
Hungary	2	11.2	1.9	99.8	6,700
Ireland	1	26.4	7.1	39.2	607
Italy	3	132	27	385	54,931
Latvia	1	1.8	0.4	25.8	1,003
Lithuania	1	4.2	0.7	42.5	1,601
Netherlands	1	66.8	10.9	126.3	5,639
Poland	1	49.5	10.6	423.6	14,625
Portugal	1	14.9	2.7	104.3	10.807


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Table 22 (part B). Food and drink industry data (source FoodDrinkEurope National Federations; 2014)


	Employment ranking in manufacturing	Turnover (Billion of €)	Value added (Billion of €)	Number of employees (x 1.000)	Number of companies
Romania	1	11.1	-	178.9	8.798
Slovakia	3	3.8	0.7	28.1	268
Slovenia	3	2.2	0.5	16	2,160
Spain	1	93.4	29	479.8	22,343
Sweden	4	18.4	4.3	54	3.965
UK	1	120.9	33.4	415	6.300

### 4.3.2 State of the sector

The contribution of this sector to Europe's economy is important with 4.25 million employees throughout the EU, over €1 trillion turnover and a positive trade balance of €25 billion.

The FoodDrink Body has estimate the following frameworks trend:

- As for the decrease in production and stable sales growth:
  - In 2017, EU food and drink industry production decreased by 0.3 %.
  - EU food and drink industry turnover increased by 1.0 % compared to the previous quarter.
  - The year-on-year comparison shows that food and drink industry turnover growth was lower than total manufacturing turnover (4.3 % vs. 6.7 % compared to 2016). Total manufacturing production growth also exceeded food and drink industry production (1.9 % vs. 0.9 % compared to 2016).
  - Food manufacturing prices increased by 1.0 % in 2017, and were 2.5 % higher compared to Q1 2016.

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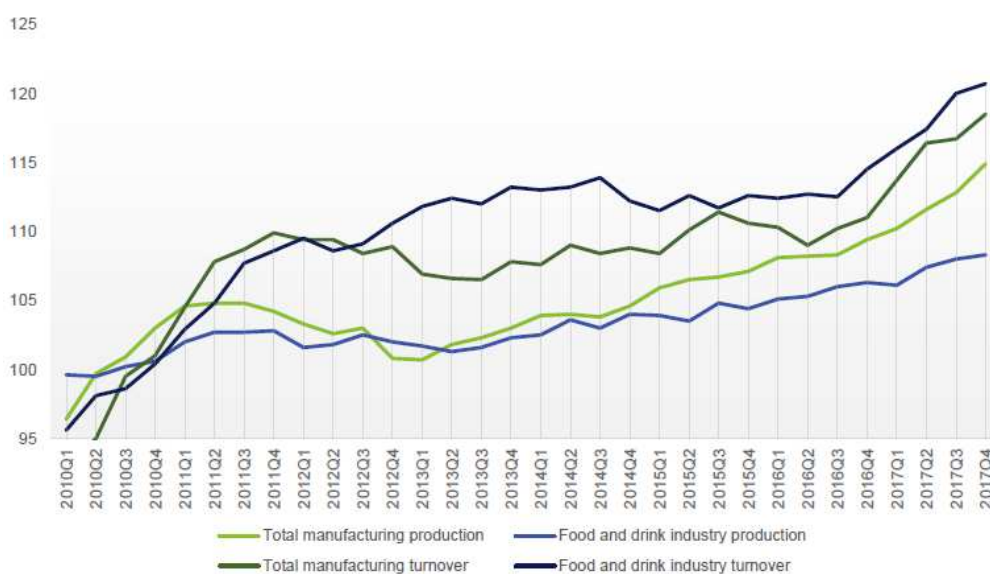


Figure 17. EU quarterly manufacturing production and turnover, 2010 - 2017 (2010=100)  
(Source: FoodDrink Europe, 2017)

- As for external trade: EU exports reached €26 billion:
  - EU exports of food and drink products totalled €26 billion in 2017 (2017 and 2016: +11.8 %). The trade surplus reached €7.5 billion in Q1 2017.
  - The top 5 products with the largest share in export value generated €12.6 billion in 2017 (meat products, dairy products, wine, spirits, processed fruits and vegetables).

More info can be found at [www.fooddrinkeurope.eu](http://www.fooddrinkeurope.eu)

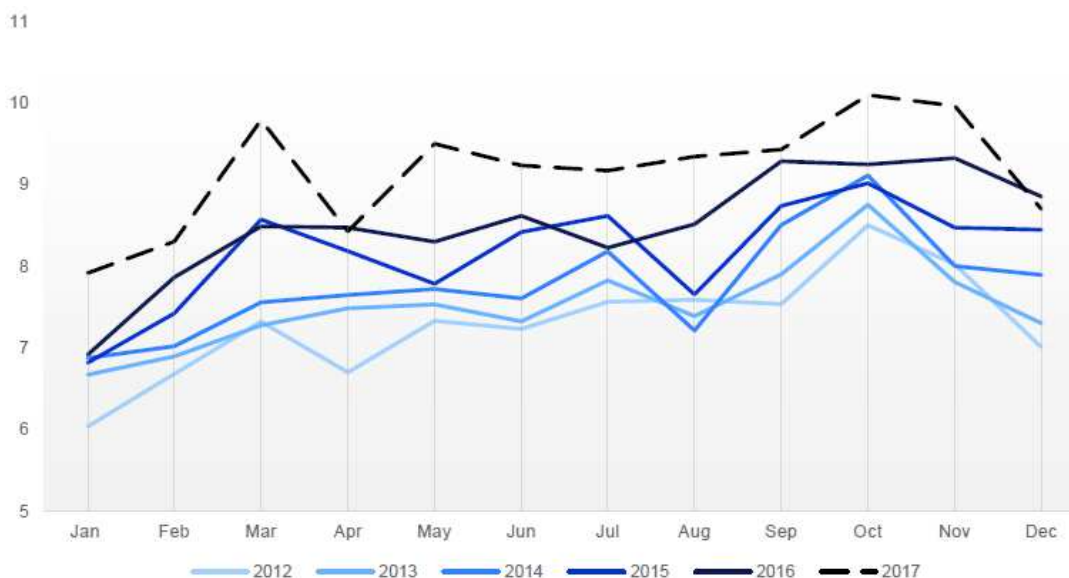



Figure 18. EU food and drink export, 2012-2017 (€ billion) (Source: FoodDrink Europe, 2017)

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### 4.3.3 Typical size of the companies

The market is led by big companies (i.e. Danone, Lactalis, Nestlè) however, SMEs role is becoming more and more relevant in the EU scenario (see Figure 19). Of course, large brands give commissions to other small local plants for food production, thus, specific investigations at country level are needed.

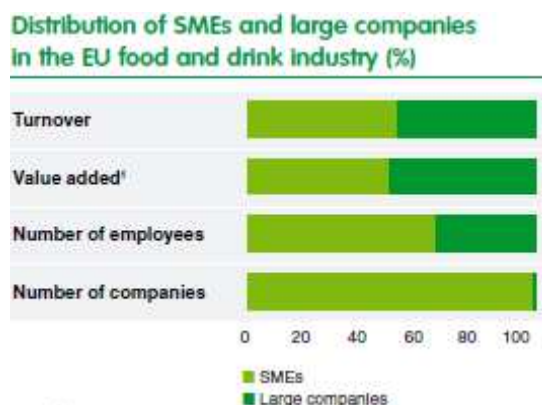


Figure 19. EU Food industries distribution (% values; source: FoodDrinkEurope 2014)

### 4.3.4 Degree of innovation

The food and beverage industry is investing a substantial amount of money to place new products on the market and to refine them.

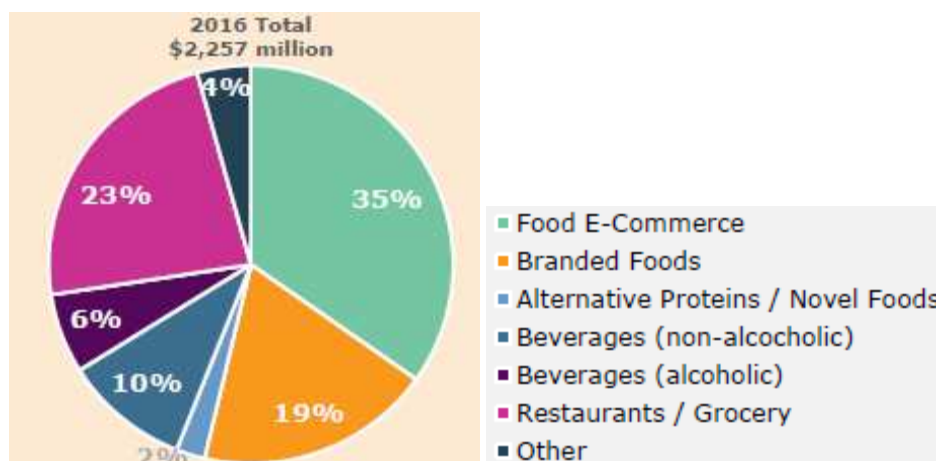



Figure 20. Total Food & Beverage Investment—By Category; source: Rabo Securities 2017)

Venture capital firms poured over \$1.1 billion last year into food and beverage startups. (Ken Fenyo, 2018).

Figure 21 shows the innovation trend in EU (2014 orange colour; 2015 blue colour).



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#### Food innovation trends in Europe (2014-2015,%)

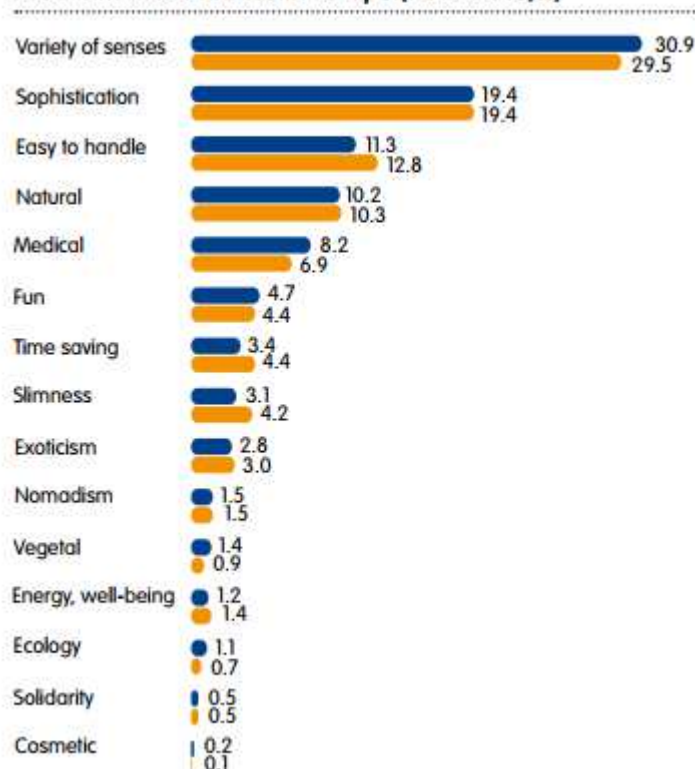


Figure 21. Food innovation in EU 2014-2015 (% values; source: FoodDrinkEurope)

## 4.4 Opportunities IBLC

### 4.4.1 Sector related residues


The main available residues are:

- Vegetable residues from fruit processing;
- Vegetable residues from vegetable processing before their freezing;
- Wine husks, that were described above;
- Beer production residues.

Unfortunately it is not possible to enter deeper into the sector, due to the strong spreading of small structures that work for their main brand. In our opinion, a creation of an IBLC could be developed in plants that process fresh vegetables, using as biomass the residues and utilizing their yards during “off-season”.

### 4.4.2 Potential synergies & benefits

All residues can be destined to biopower energy production with consideration to emissions limits set by the national regulation. The provision of a secure, continuous energy supply is becoming an issue for all sectors of society. The food processing industry as a major energy user must address

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these issues. Anaerobic digestion of food waste is an opportunity to produce energy in a sustainable manner. The most important reason that food waste should be anaerobically digested is for capturing the energy content. Unlike biosolids and animal manures, post consumer food scraps have had no means of prior energy capture. In fact, in a study done by East Bay Municipal Utility District<sup>7</sup> it was revealed that food waste has up to three times as much energy potential as biosolids. Moreover, food waste in landfills generates methane, a potent greenhouse gas. Diverting food waste from landfills to wastewater treatment facilities allows for the capture of the methane, which can be used as an energy source. In addition to decreased methane emissions at landfills, there are greenhouse gas emissions reductions due to the energy offsets provided by using an on-site, renewable source of energy (US EPA, 2016).

#### 4.4.3 Market developments

Cleaner production, supply chain and life cycle assessment approaches all have a part to play as tools supporting a new vision for integrated energy and waste management. The sector reliance on high-energy processing, such as canning and freezing/chill storage, might also need re-assessment together with processing based on hurdle technology defined as the use of a combination of barriers to microbial growth and possible spoilage or pathogenicity.

Processing residues such as fruit pulps are interesting in the framework of an IBLCs set up. Technological development for such by-products into bioproducts may become significant and has to be taken into account. Again, data about processing volumes of companies is confidential.


#### 4.4.4 Non-technical barriers

The main non-technical barrier is related to economic aspects. The price of fossil fuel is actually relatively low and this can influence the decision to invest for bioenergy plants. Additionally, implementation of IBLC is linked with additional financial investments and relatively long period for return of investments.

No other relevant non-technical barriers are foreseen for this sector.

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<sup>7</sup> <https://www.epa.gov/sites/production/files/documents/Why-Anaerobic-Digestion.pdf>

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## 6 ANNEX – SUMMARY OF SECTORS

Table A. Summary sector of seed oil

Sector seeds oil	
	Profile
Production	<ul style="list-style-type: none"> <li>34,000 tons crushed in EU.</li> </ul>
Volume of the sector	<ul style="list-style-type: none"> <li>11.5 millions of hectares cultivated in EU.</li> </ul>
State of the sector	<ul style="list-style-type: none"> <li>Stimulated by biodiesel and renewable energy demand.</li> </ul>
Typical size of the companies	<ul style="list-style-type: none"> <li>When comparing these figures with other sector industries, vegetable oil industries seem to be high sized and with more available economic assets.</li> </ul>
Distinctive facilities of the sector	<ul style="list-style-type: none"> <li>Although vegetable oil extractor industries do not have any specific equipment compatible with the processing of biomass, they have other valuable resources such as the access to workforce, means of transport, silos to storage the seeds, etc., which could be very useful at the time of implement an IBLC in their facilities.</li> </ul>
Degree of innovation	<ul style="list-style-type: none"> <li>Only for by-products.</li> </ul>
Miscellaneous	<ul style="list-style-type: none"> <li>.LCIA done by Fediol on seed crushing.</li> </ul>
	Opportunities for IBLCs
Sector related residues	<ul style="list-style-type: none"> <li>Hulls, expeller, meal, mainly sent to animal feed industry.</li> </ul>
Potential synergies & benefits	<ul style="list-style-type: none"> <li>Hulls used for bioenergy production (in bulk or pelletized).</li> </ul>
Market developments	<ul style="list-style-type: none"> <li>Very good market performances. Companies are investing in different pheses of the value chain.</li> </ul>
Non-technical barriers	<ul style="list-style-type: none"> <li>Citizens acceptability of emission from hulls burning.</li> </ul>


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Table B. Summary sector olive oil

Sector olive oil	
	Profile
Production	<ul style="list-style-type: none"> <li>More than 4.5 millions of hectares (70 % of the world production).</li> </ul>
Volume of the sector	<ul style="list-style-type: none"> <li>In Spain, Italy and Portugal, the olive tree/farming surface represents 8-9 % of the total agricultural national surface (national UAA), while in Greece it is 20 %. 2.322.300 t of olive oil produced in EU (2015).</li> </ul>
State of the sector	<ul style="list-style-type: none"> <li>It is static.</li> </ul>
Typical size of the companies	<ul style="list-style-type: none"> <li>Size differs between countries. The typical size of the Greek companies in this sector differs from the Spanish or the Italian ones. In Greece, olive mills are mostly owned by cooperatives controlled by farm owners.</li> </ul>
Distinctive facilities of the sector	<ul style="list-style-type: none"> <li>Facilities such as storage areas, dryers, centrifugators or purification systems can be also used for different purposes. For example the storage areas can be used in order to store prunings or mulched material from olive or vine prunings that are produced from the olive trees or vines from the nearby areas. Moreover, the centrifugators and the purification systems can be used from the wine industry as well as from the vegetable oil extraction sector in order to extract their main products. Furthermore, dryers used in pomace mills, can find various applications during their idle times like drying other materials such as olive prunings, cereals etc.</li> </ul>
Degree of innovation	<ul style="list-style-type: none"> <li>Shifting of the processing from 3-phases to 2-phases processing.</li> </ul>
	Opportunities for IBLCs
Sector related residues	<ul style="list-style-type: none"> <li>Pomace, that can be used for domestic heating and industrial power generation and biochemical products. Prunings for energy generation.</li> </ul>
Potential synergies & benefits	<ul style="list-style-type: none"> <li>Storage of material.</li> </ul>
Market developments	<ul style="list-style-type: none"> <li>In progress especially for bio-compounds.</li> </ul>
Non-technical barriers	<ul style="list-style-type: none"> <li>Nothing to be underlined.</li> </ul>


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Table C. Summary sector wineries and distilleries.

Sector wineries and distilleries	
	Profile
Production	<ul style="list-style-type: none"> <li>The EU surface accounts almost to 50 % of the global area dedicated to vineyards.</li> </ul>
Volume of the sector	<ul style="list-style-type: none"> <li>The production in volume is 65 % (expressed in tons).</li> </ul>
State of the sector	<ul style="list-style-type: none"> <li>The market is much alternating depending on the season. An interesting part of the European wine is exported to Russia. Unfortunately, the embargo to Russia had a strong affectly the market. 16.285.000 l of wine produced in EU (2015).</li> </ul>
Typical size of the companies	<ul style="list-style-type: none"> <li>Many “in-house” cellars. The attention should be focused on distilleries.</li> </ul>
Distinctive facilities of the sector	<ul style="list-style-type: none"> <li>Despite distilleries represent quite a small part of wine sectors in comparison with cellars, these industries have great opportunities for becoming IBLC’s. They own equipment compatible for the processing of solid biomass and the extraction of bioactive compounds.</li> </ul>
Degree of innovation	<ul style="list-style-type: none"> <li>The most important innovations seems to be are related in the increasing of the efficiency regarding the fermentation and extracting processes, as well the process cost reduction.</li> </ul>
	Opportunities for IBLCs
Sector related residues	<ul style="list-style-type: none"> <li>Grape marc and prunings.</li> </ul>
Potential synergies & benefits	<ul style="list-style-type: none"> <li>Storage yards and use of marc for energy and bioproducts production.</li> </ul>
Market developments	<ul style="list-style-type: none"> <li>In development for bio-products. As for prunings the market is consolidated.</li> </ul>
Non-technical barriers	<ul style="list-style-type: none"> <li>No non-technical barriers are foreseen.</li> </ul>


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Table D. Summary sector feed on fodder.

Sector feed and fodder	
	Profile
Production	<ul style="list-style-type: none"> <li>Animal feed comes from residues of other agricultural processes, and it is sold in form of pellets.</li> </ul>
State of the sector	<ul style="list-style-type: none"> <li>No residues seem to be produced by this sector.</li> </ul>
Typical size of the companies	<ul style="list-style-type: none"> <li>There are large companies that commercialize various products. Of course, they give commissions to third parties.</li> </ul>
Degree of innovation	<ul style="list-style-type: none"> <li>Mainly the individuation of new protein sources.</li> </ul>
	Opportunities for IBLCs
Sector related residues	<ul style="list-style-type: none"> <li>To act as intermediate for IBLCs (mainly storage).</li> </ul>
Potential synergies & benefits	<ul style="list-style-type: none"> <li>Storage.</li> </ul>
Market developments	<ul style="list-style-type: none"> <li>Not available for confidentiality matters between companies.</li> </ul>
Non-technical barriers	<ul style="list-style-type: none"> <li>Eventual use of additives.</li> </ul>



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Table E. Summary sector grain chain

Sector grain chain	
	Profile
Production	<ul style="list-style-type: none"> <li>EU is not self-sufficient. The production of cereals (including rice) in the EU-28 was around 317 million of tons in 2015.</li> </ul>
Volume of the sector	<ul style="list-style-type: none"> <li>Cereals have to be considered as “commodities”. Thus, the economic figures depend on the market conjuncture.</li> </ul>
State of the sector	<ul style="list-style-type: none"> <li>Please take into account geopolitical situation, embargoes, climate, etc.</li> </ul>
Typical size of the companies	<ul style="list-style-type: none"> <li>All over Europe there are a lot of small mills operating also for large brands.</li> </ul>
Degree of innovation	<ul style="list-style-type: none"> <li>Technology is consolidated. Reduction of energy consumption is on-going.</li> </ul>
	Opportunities for IBLs
Sector related residues	<ul style="list-style-type: none"> <li>Since the most of cereal grains seem to be delivered at mills, already mostly cleaned from residues, the only by-products useful seems to be used is rice hulls. As for cereal straw, due to the structure of its market in which the larger industries are not involved, it does not presents an opportunity for IBL (just for the moment).</li> </ul>
Potential synergies & benefits	<ul style="list-style-type: none"> <li>Storage, new technologies for rice husk uses.</li> </ul>
Market developments	<ul style="list-style-type: none"> <li>Information are confidential and not available</li> </ul>
Non-technical barriers	<ul style="list-style-type: none"> <li>No important no-technical barriers are foreseen.</li> </ul>


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Table F. Summary sector sugar industry.

Sector sugar industry	
	Profile
Production	<ul style="list-style-type: none"> <li>EU is the world's leading producer of beet sugar, with around 50 % of the total in terms of tons.</li> </ul>
Volume of the sector	<ul style="list-style-type: none"> <li>Due to the spreading and sub-contracting of production, it is not so easy to individuate the single facility which then may be able to act as a IBLC platform.</li> </ul>
State of the sector	<ul style="list-style-type: none"> <li>The sector needs more specific analysis.</li> </ul>
Typical size of the companies	<ul style="list-style-type: none"> <li>The sub-contractor agreements with brand companies does not allow to have a frame of the situation.</li> </ul>
Degree of innovation	<ul style="list-style-type: none"> <li>Decreasing the energy input of the sugar extraction and refining.</li> </ul>
	Opportunities for IBLCs
Sector related residues	<ul style="list-style-type: none"> <li>Bagasse and sugar beet vinasse.</li> </ul>
Potential synergies & benefits	<ul style="list-style-type: none"> <li>Related to animal food market. If developed, bio-products should represent a good opportunity</li> </ul>
Market developments	<ul style="list-style-type: none"> <li>Actually, no new market are foreseen.</li> </ul>
Non-technical barriers	<ul style="list-style-type: none"> <li>No non-technical barriers are foreseen at the moment.</li> </ul>


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Table G. Summary sector Food processing industry

Sector food processing industry	
	Profile
Production	<ul style="list-style-type: none"> <li>More than 285,000 SMEs that generate almost 50 % of the food and drink industry turnover and value added and provide 2/3 of the employment of the sector.</li> </ul>
Volume of the sector	<ul style="list-style-type: none"> <li>4,25 million employees throughout the EU, over €1 trillion turnover and a positive trade balance of €25 billion</li> </ul>
Typical size of the companies	<ul style="list-style-type: none"> <li>Large brands give commission to other small plant. Thus, the specific investigation per site needs a deep and thorough analysis.</li> </ul>
Distinctive facilities of the sector	<ul style="list-style-type: none"> <li>Not available.</li> </ul>
Degree of innovation	<ul style="list-style-type: none"> <li>The food and beverage industry is investing a substantial amount of money to place new products on the market and to refine them.</li> </ul>
	Opportunities for IBLCs
Sector related residues	<ul style="list-style-type: none"> <li>Vegetable residues from fruit processing;</li> <li>Vegetable residues from vegetable processing before their freezing;</li> <li>Wine husks;</li> <li>Beer production residues.</li> </ul>
Potential synergies & benefits	<ul style="list-style-type: none"> <li>Biopower energy production.</li> </ul>
Market developments	<ul style="list-style-type: none"> <li>New technology needs to be developed in a framework of an IBLCs set up. The use of such by-products in processing/transforming them into bioproducts has to be taken into account (confidential informations).</li> </ul>
Non-technical barriers	<ul style="list-style-type: none"> <li>No non-technical barrier are foreseen.</li> </ul>