Basic analysis of targeted agricultural sectors

D6.2.5 Country Report Serbia

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ABBREVIATIONS

CAP	Common Agricultural Policy
CEFTA	Central European Free Trade Agreement
EU	European Union
EUR	euro
FFA	free fatty acid
GDP	gross domestic product
ha	hectare
IBLC	Integrated Biomass Logistics Centre
l	litre
MJ	Mega joule
RS	Republic Serbia
t	tonne
toe	tonnes of oil equivalent
UAA	utilised agricultural area
USD	United States dollar

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

SPANISH CO-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

EXECUTIVE SUMMARY

The report analyses the following five sectors of the agro-economy segment in Republic of Serbia: sugar industry, wine sector, vegetable oil extraction, grain chain, and feed and fodder. Each sector chapter consists of two main parts: a general sector description and a second part concerning sector's interest from the IBLC concept perspective. The grain chain and vegetable oil extraction sectors are dominant due to the fact that they generate large amounts of by-products and residues, during the primary production of respective crops, and later during the stages of industrial processing. Those residues can be used as feedstock for production of solid biofuels (e.g. agro pellets). Log wood is the traditional primary energy source for heating in Republic Serbia as well as coal but recent development of pellet production and specialized combustion equipment for this type of fuel have opened the opportunities for utilisation of various agro residues in this field.

There is a significant surplus in processing capacities in the vegetable oil extraction sector, which is a potential opportunity for IBLC implementation. Nevertheless logistics is the main obstacle for further development of vegetable oil market due to the numerous number of small famers with insufficient capacities for operation according to modern standards, variability of prices, and transportation problems related to biomass delivery.

The sugar industry sector generates significant amount of residues and by-products, which can be used as biomass feedstock – primarily sugar beet press (pulp) and molasses. In particular, the first can be used for the production of biogas, whereas the second one is suitable for the production of bioethanol. However, at this moment there are no capacities in Serbia for the production of either biogas from sugar beet press or bioethanol from molasses.

The feed and fodder sector has no surpluses that can be used for the production of biofuels. Anyway significant production capacities are in surplus, that can be used for processing grain and vegetable biomass feedstock generated by other sectors into solid biofuels.

Serbian agro-industry has the potential for IBLC development in following sectors: vegetable oil extraction, wine sector, sugar industry and grain chain. The main opportunities for these sectors are:

- Significant potential for biomass utilization.
- High infrastructure and well development of selected sectors.
- Existing knowledge and efforts made to implement modernization according to best practices and improvements made in energy efficiency in last decade.
- Potentials for further investment.

Additionally, during the sectors analysis different obstacles were identified:

- Unresolved relationship due to land property issues and the poor leasing of state land.
- Small farms with insufficient capacities for operation according to modern standards.
- Economic aspects: relatively low price of fossil fuel compared to biomass, variability of prices, high input prices and problems with loan repayments for equipment and machinery.
- Uncertainty related to policy measures.

- Transportation problems for biomass delivery - bad road infrastructure, bad conditions in railway sector and insufficient use of river transport.

In Republic of Serbia, renewable energy sources with an estimated technically usable potential of about 5.6 Mtoe per annum can have a considerable contribution to a lesser utilization of fossil fuels and achievement of defined targets regarding the share of renewable sources in the GFEC (27 % in 2020). The biomass potential amounts is approximately 3.4 Mtoe per year (2.3 Mtoe per year is unused, and 1.1 Mtoe is used). The main part of unused biomass comes from the agriculture sector and for this reason IBLC could have a very important role concerning the fulfilment of RES' target.

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1 INTRODUCTION

This country report was written within the scope of the Task 6.2 "Basic analysis of targeted agricultural sectors" of the AGROinLOG project "Demonstration of innovative integrated biomass logistics centres for the Agro-industry sector in Europe". The primary aim of this report is to provide an actual overview of the agro industry for selected sectors in Serbia, and give specific information with respect to the IBLC related topics. The sectors of the agro-industry in Serbia considered in this report are: the sugar industry, the vegetable oil extraction, the wine sector, the grain chain and the feed and fodder sector. In addition, based on data which will be presented in the following sections, the aim of the report is to define the potential in all or in some of the selected sectors for implementation of the IBLC concept. Therefore, each sector chapter effectively consists of two parts: general overview of the sector current state and an assessment of IBLC opportunities.

In order to easier defining the overview for selected agricultural sector, the methodology of territory division related to the Statistical Office of the Republic of Serbia is used. According to Nomenclature of Territorial Units for Statistics, Serbia is divided into five NUTS 2 regions: Vojvodina, Belgrade, Sumadija and Western Serbia, Southern and Eastern Serbia and Kosovo and Metohija which are shown on Figure 1.

Figure 1. Statistical regions in Serbia. Source: Statistical Office of the Republic Serbia, 2013.

Agro-industry in Serbia is at the heart of the economy and is an engine for development of rural areas. In 2016, agriculture accounted for 11.9 percent of GDP, 2.4 percent higher than 2015, mostly

due to very favourable weather conditions and record yields achieved. This large share in the country's GDP has mostly resulted from Serbia's fertile land and natural conditions for agricultural production, as well as the continued importance of the rural economy to Serbia's population and delays in structural reforms in other sectors of the economy. According to the Serbian Statistical Office, there are 680,000 people employed in agriculture or 21 percent of the total labour force in the country. Agriculture also is the most important export sector in Serbia. In 2016, agriculture and food production accounted for 19.4 percent of all Serbian exports and enjoyed a trade surplus of USD 1.4 billion, USD 130 million more than in 2015 (mostly due to an increase in exports of processed fruit and vegetable). The major part of agricultural land is in the northern part of the country; Vojvodina accounts for 84 percent of total cultivated land in Serbia (Figure 2).

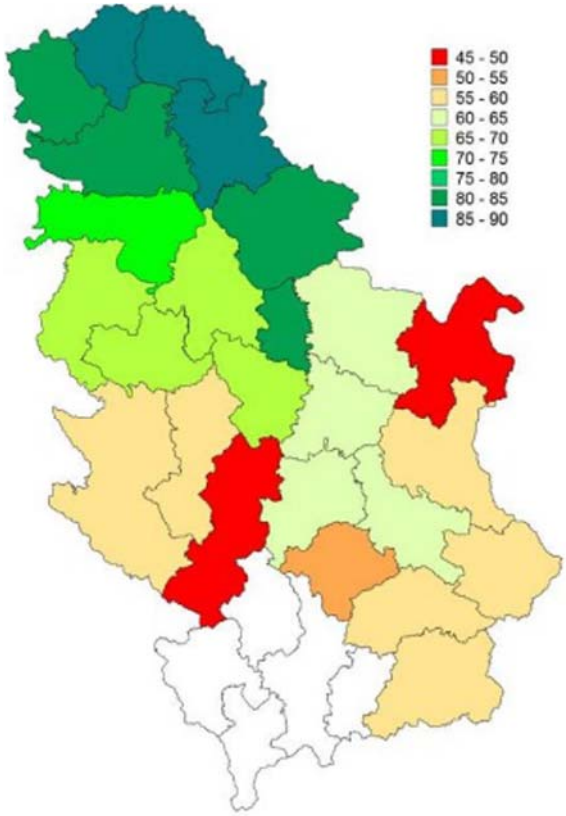

Figure 2. Arable vs total area in %. Source: Statistical Office of the Republic Serbia, 2013.

Approximately 60 percent of Serbia's agricultural land is used for cereal crop production (including corn, wheat, barley), sunflowers, soya, and sugar beets. More than 60 % of the value of the agricultural production is generated by plant production and 40 % by livestock production. The main plant products are maize, wheat, oilseeds, sugar beet, fruits and vegetables.

The country has 5.05 million hectares (ha) of arable land. Approximately 90 percent of this land is privately owned and 10 percent belongs to the state. Serbia's utilised agricultural area (UAA) is 3,437,423 ha, which accounts for 44 % of the total territory. Arable land is the predominant land use

(73 %) followed by permanent grassland (21 %) and permanent crops (6 %). Serbia has defined areas with difficult working conditions for agriculture[1].

This less favoured area" covers 39 % of the total surface and 24 % of the utilised agriculture area used by 29 % of the farms.

According to the Serbian Agriculture Census from 2012, there are approximately 630,000 registered agricultural entities of which approximately 99.6 percent are family households and 0.4 percent are other legal entities. The average size of the family holding is only 4.5 ha large and the average size of commercially registered farms is 10.6 ha.

The largest share in the total number of holdings (48.1 %) consists of small farms (up to 2 ha of land, which are using only 8 % of the area). The holdings with less than 5 ha are 77.4 % of the total number of farms and they occupy about 25 % of utilized agricultural land (UAA). In contrast, the largest farms, over 50 ha, account only up to 1 % of the total number of farms, and cultivate about one third of UAA. One of the reasons for low agricultural productivity in Serbia is the poor level of relevant professional skills, especially regarding farm management.

The agricultural census registered 631,500 agricultural holdings with an average size of 5.4 ha. 99.5 % of the holdings are family farms. Serbia's agriculture is characterised by a mixed farm structure with:

- 6,200 large farms with more than 50 ha using 33 % of the UAA
- 45,300 medium seized farms with 10-50 ha using 24 % of the UAA
- 271,600 small farms with 2-10 ha using 35 % of the UAA
- 308,400 subsistence or semi-subsistence farms with less than 2 ha using 8 % of the UAA

The climate conditions in Serbia are generally favourable for agriculture and Serbia has rich land resources with a good soil quality, a rich biodiversity and a good ratio of agricultural land per capita. Despite these favourable conditions, labour productivity is 20 % below the EU average. Product yields are well below potential, mainly due to lack of finance, modern technology, sufficient input levels, genetic resources and knowledge. Production is also affected by climate change. Farmers are vulnerable to extreme weather conditions which, in recent years, have resulted in increased volatility of production. Nevertheless, Serbia is a net exporter of agricultural products with a favourable ratio between exports and imports of 1.5 to 2 in recent years. Trade consist mainly of primary agricultural products (79 % of exports and 65 % of imports).

Despite its economic and political importance, the Serbian agricultural sector is still hampered by a variety of constraints limiting its full potential. Aside from outdated production technologies and machinery, the lack of adequate infrastructure (e.g. storage/cooling facilities) and inadequate irrigation and drainage systems, the lack of sufficient agricultural finance in comparison to other sectors is considered by many observers to be one of the major impediments to the growth and

[1] The following criteria were used: Altitude- above 500m or less than 100 employed/1,000 citizens or belonging to a nature park. This definition is not aligned yet with the definition of less favoured areas based on EU legislation.

development of the sector. However, although Serbia has remarkable natural resources and a strong production and processing background, in many areas both industry and farms lack modern technology and strongly need technical assistance and increased financial resources for further development. As a result of weakness in technology and access to finance, Serbia does not have productivity on the level of the EU, or, in many cases even on the level of its neighbours.

Considering that Serbia is not yet a member of the EU, the methodology for collecting data from the agricultural sector differs from the methodology applied in the EU. This was the biggest particular constrains during the preparation of this country report, because the data obtained from the national statistical office had to be compared with the data obtained from the field. This is done in order to get relevant information for example about the cultivated areas for specific crop, produced capacities or classification of certain products where the most frequent deviations can be found. In recent years, since Serbia is EU candidate country, its legal framework and the organization of certain state bodies must be harmonized with the EU. This fact makes the difference in some methodology and analysis significantly reduced, but still it could be a fundamental problem in document preparation and country reporting like this. In the following sections, the main characteristics of selected agriculture sectors will be presented, as well as, the opportunities and barriers for IBLC implementation.

2 SUGAR INDUSTRY

2.1 Profile of the sugar industry sector

2.1.1 Production

Traditionally, the sugar industry is one of the key agro-industries in the Republic of Serbia. This position was acquired thanks to the quality of the soils and the favourable climatic conditions that are conducive to the sugar beet cultivation. The sugar beet foreign hybrids production prevails and they are used as the main raw material for sugar production in Serbia. Total production of the sugar beet is mainly dedicated for the needs of the domestic sugar industry. Also the traditional commitment to sugar production as an important agricultural branch has contributed. Unlike other agro-industry sectors in Serbia, production technologies in sugar industry have developed over the years and have largely followed up modern trends in sugar production. In addition to the basic technological process of sugar production (Figure 3), technology includes auxiliary processes and operations in power generation plants, auxiliary materials and the processing of by-products.

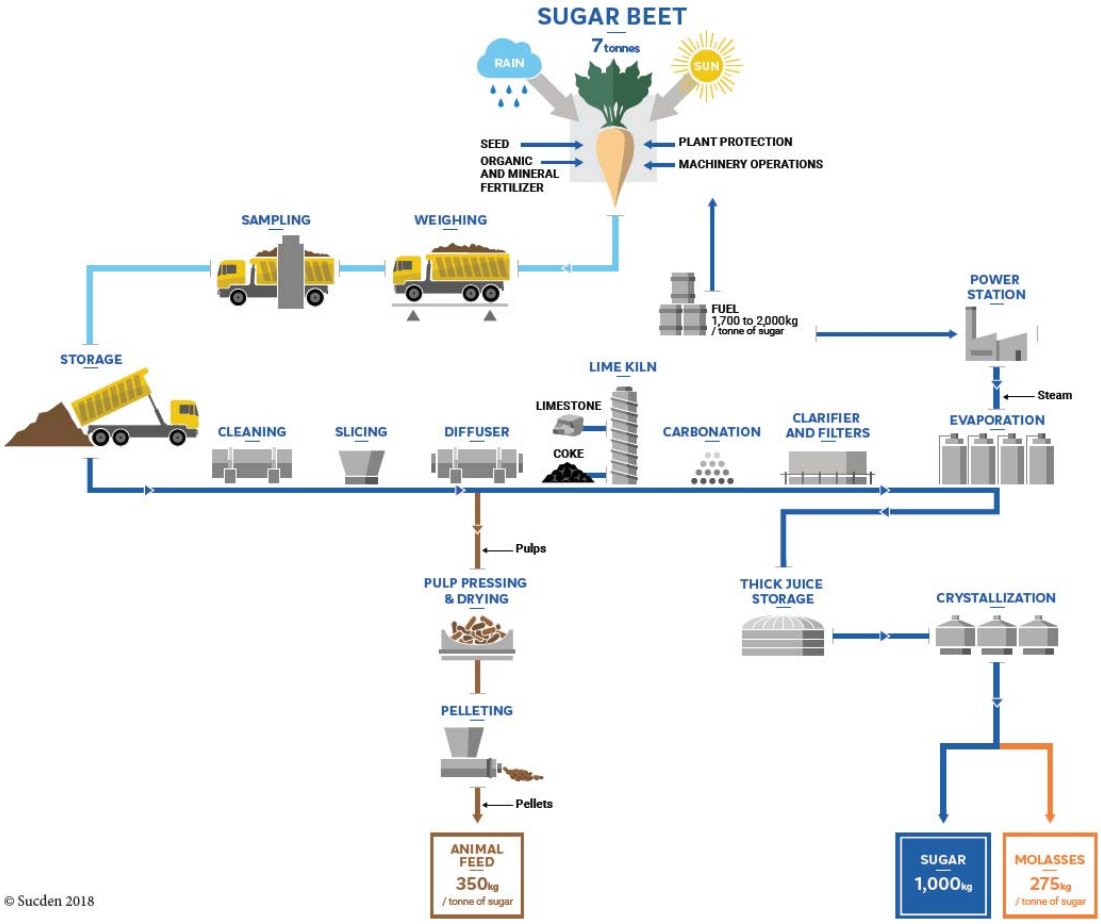

Figure 3. Sugar production process. Source: https://www.sucden.com/, 2018.

The basic technological process of sugar production can be divided into 7 phases:

1. Dose and weighing sugar beets, taking a sample
2. Wet or dry unloading of sugar beets, beet washing, cutting the beets on the noodles
3. Extraction of tail noodles, extraction of juice and dried noodles
4. Cleaning the juice
5. Concentration and evaporation of the juice
6. Crystallization of sugar
7. Finishing crystalline sugar

2.1.2 Volume of the sector

In the domestic agriculture production, sugar beet takes a significant place. The annual production of sugar beet was in the range from 2,200,000 to about 3,300,000 t in the period from 2006 to 2016 (Table 1). For production of sugar beet between 1 and 1.5 % of the total available land is used in Serbia. It is produced by farms with more than 100 ha (≈ 400 farms).

Table 1. Sugar beet production in Serbia 2006-2016. Source: Statistical Office of the Republic Serbia, 2017.

Sugar beet production in Serbia 2006-2016				
Year	Harvested area (ha)	Production (t)	Yield (t/ha)	Export (t)
2006	76,130	3,397,570	44.6	80,000
2007	84,085	3,412,089	40.6	92,000
2008	51,261	2,454,605	47.9	129,000
2009	65,354	2,977,781	45.6	90,000
2010	70,968	3,551,074	50.0	338,000
2011	59,221	3,004,237	50.7	205,000
2012	69,069	2,482,962	35.9	-
2013	66,527	3,180,008	47.8	-
2014	64,112	3,507,441	54.7	34,000
2015	42,123	2,183,194	51.8	21,000
2016	49,237	2,683,860	54.5	100,000

As shown in Table 1 in the period of last ten years, the areas under the sugar beet were extremely unstable according to actual Agriculture Strategy 2014-2020, Belgrade 2014. Regarding to these facts sugar production has also changed: sugar production varies with the changes in the production of sugar beet (400,000 to 500,000t of sugar a year, mainly). So according to the Statistical Yearbook of Serbia in 2015, the production of refined sugar in 2014 amounted 546,000 t, and in 2015 329,440 t [Statistical Office of the RS - Agricultural database, 2017]. Production of sugar in 2015 reduced by 40 % compared to 2014 due to climate conditions. Despite this, the domestic market was supplied with sugar, since domestic production provides significant market surpluses every year. Existing surpluses are mainly exported to EU countries.

The cultivation of sugar beet is done mainly on arable land located on north part of Serbia in the region of Vojvodina. The most important sugar production facilities is also located in that region. The main producers are listed below and presented on Figure 3.

Today, in the Republic of Serbia, seven sugar factories are operating (Figure 4), whose processing capacity, based on average 100 days of processing, is about 4,400 million tonnes which are transported in over 150,000 trucks. The Serbian beet processing sector has gone through a process of rationalization during which a number of factories closed, and the remaining factories invested heavily to expand their capacity. The main sugar production facilities are:

- Production Centre Pećinci (former Donji Srem), located in Pećinci (1)
- Production Centre Bačka, located in Vrbas (2)
- Production Centre Kovačica (former Jedinstvo), located in Kovačica (3)
- Jugozapadna Bačka, located in Bač (4)
- The Sugar Factory "Crvenka", located in Crvenka (5)
- The Sugar Factory "Šajkaška", located in Žabalj (6)
- TE-TO Senta, located in Senta (7)

Figure 4. Main sugar production facilities in Serbia. Source: Hickingbottom & Jackson, 2013.

2.1.3 State of the sector

There are 15 sugar factories in Serbia (in Pećinci, Vrbas, Kovačica, Bač, Crvenka, Žabalj, Senta, Sremska Mitrovica, Kovin, Zrenjanin and Nova Crnja, Šabac, Beograd, Ćuprija and Požarevac). According to the data of the Serbian Business Registers Agency, 8 of the above mentioned factories are undergoing bankruptcy. The facilities still operating today are presented in Table 2.

There are no official industry standards that define the relationship between beet growers and processors in Serbia. Each factory carries out its own contracting directly with the farmers who supply beets.

Approximately 180,000 to 200,000 t/year are exported. The export of sugar to the EU is managed by export licences. The EU has limited the amount of sugar export to its market to181,000 t/yr without additional duty. Serbia stated that it applies an ad valorem (20 %) and specific import duties for raw sugar (EUR 0.14/kg) and white sugar (EUR 0.15/kg). The specific import duties are reduced for imports from the EU, CEFTA, Turkey, Belarus and Kazakhstan. Trade with CEFTA countries and the Russian Federation is completely liberalised.

Table 2. Sugar consumption in Serbia 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Sugar consumption in Serbia 2006-2016					
Year	Food use (t)	Industrial use (t)	Export (t/ha)	Closing stocks[2] (t)	Total consumption (t)
2006	99,000	144,000	222,000	38,000	503,000
2007	99,000	144,000	224,000	56,000	523,000
2008	93,000	130,000	183,000	50,000	456,000
2009	100,000	147,000	235,000	14,000	496,000
2010	95,000	145,000	242,000	44,000	526,000
2011	95,000	145,000	190,000	54,000	484,000
2012	95,000	150,000	181,000	63,000	489,000
2013	100,000	150,000	276,000	78,000	604,000
2014	100,000	150,000	307,000	143,000	700,000
2015	100,000	150,000	193,000	24,000	467,000
2016	100,000	150,000	237,000	139,000	626,000

Table 3. Main sugar production facilities in Serbia. Source: Sunoko; Šajkaška, 2017.

[2] Closing stock is the amount of inventory that a business still has on hand at the end of a reporting period. This includes raw materials, work-in-process, and finished goods inventory. The amount of closing stock can be ascertained with a physical count of the inventory. It can also be determined by using a perpetual inventory system and cycle counting to continually adjust inventory records to arrive at ending balances. The opening stock for the next reporting period is the same as the closing stock from the immediately preceding period [AccountingTools, 2018].

Main sugar production facilities in Serbia			
Factory	Owner	Maximum processing capacity of sugar beet (t/year)	Maximum sugar production (t/year)
Production Center Pećinci	Sunoko	800,000	100,000
Production Center Bačka	Sunoko	600,000	100,000
Production Center Kovačica	Sunoko	700,000	100,000
Jugozapadna Bačka	Sunoko	300,000	40,000
The Sugar Factory "Crvenka"	Hellenic Sugar Industry	650,000	105,000
The Sugar Factory "Šajkaška"	Hellenic Sugar Industry	550,000	50,000
TE-TO, Senta	Sunoko (former owner Sfir, Italy)	800,000	100,000

The structure of companies in the sugar industry is dominated by medium and large companies representing more than 10 % of the total number of companies within the entire agro-industry branch. The equipment in the sugar industry is such that in larger plants the equipment is better. In 2016, the processing capacities of factories that are in operation, operated with 60 % capacity. The trend in the last ten years is that sugar production in Serbia is increasing. The factories are owned by two companies - "Helenik Sugar" and "Sunoko". The fact that two sugar producers operate in this market certainly opens the issue of monopoly, both at the market of raw materials, and selling final product, especially related to the high consumer prices.

The total consumption of sugar in Serbia is around 25-30 kg per capita, which is about 240,000t per year. On the other hand, the annual production of refined sugar in 2010 exceeded 500,000 t, so sugar represents a product that is exported from Serbia (Table 2).

2.1.4 Typical size of the companies

In Serbia, several companies (production centres) are dealing with sugar production and all these companies will be will be described in this section.

Production Centre Pećinci is one of the state-of-the-art sugar plants in the region. During the sugar beet processing campaign, this factory has the highest processing capacity.
Employees: 127 permanent employees, 7 fixed-term employees and around 140 seasonal workers.
Capacities: The plant processes 8,000 t of sugar beet daily and produces 1,150 t of sugar. The annual capacity of sugar beet processing reaches 800,000 t, which is one fifth of the annual sugar beet crop in Serbia.

Production Centre Bačka was founded in 1913 and it is the oldest sugar plant in Serbia.
Employees: 147 permanent employees, 3 fixed-term employees and around 140 seasonal workers.
Capacities: The daily capacity of sugar beet processing is around 6,000 t, which gives around 900 t of sugar daily. The annual capacity of processing is around 600,000 t of processed sugar beet, which represents 15 % of the annual sugar beet production. Planned maximum annual capacities:

- 80,000 t of sugar
  - 22,000 t of molasses
  - 23,000 t of dry pulp pellets.

Production Centre Kovačica was founded in 1976.
Employees: 128 permanent employees, 13 fixed-term employees and around 120 seasonal workers.
Capacities: After the privatisation of the factory in 2002, the daily sugar beet processing capacity jumped from the former 4,000 t to the current 7,000 t. The annual capacity of sugar beet processing is 700,000 t, which represents 17.5 % of the annual sugar beet production, whereas the daily production of sugar is 1,000 t.

The Sugar Factory "Crvenka" was founded in 1912.
Employees: about 218 workers
Capacities: Its optimum slicing capacity is 6,500t of sugar beet per day and 1,000 t of sugar per day, as well as 350 t of dried briquetted sugar beet pulp and 250 t of molasses. Dried briquetted are used as animal food. The molasses is used for production of additional quantities of sugar and as a component for animal food. Today, the factory is in the process of ownership transformation in order to form a stock company again. The development of the Sugar Factory, above all, implied the expansion of its capacity. The annual processing capacity is around 780,000 t of processed sugar beet, which is 19.5 % of the annual sugar beet production.

The Sugar Factory "Šajkaška" was founded in 1976 and it started operation in 1979. Since the company's establishing until the year 2006, the factory has had 28 sugar beet campaigns and processed in total 7,015,000 t of sugar beet.
Employees: 178 permanent workers out of which 17 with a high professional education and 4 with a higher professional education. During the campaign period, 140 seasonal workers are additionally employed.

Capacities: 5,500t of sugar beet/day. The annual processing capacity is around 660,000 t of processed sugar beet, which is 16.5 % of the annual sugar beet production.

2.1.5 Distinctive facilities of the sector

Sugar producing facilities are located mainly in the North part of Serbia, in Vojvodina. The total capacity is higher than needed. Average efficiency of Serbian factories is now close to that of the EU as a whole, and greater than that of the other industries in the region. Additionally, the factories owned by Sunoco transport beets over relatively short distances which reduce the cost of production compared to other factories (the Crvenka factory has the shortest hauling distances and the Senta factory the longest. See for further information http://www.sunoko.rs/en/production-centers/).

There is a huge difference in the cost of fuel between the factories that burn coal (all of which are owned by Sunoko) and those that use gas. Till now, sugar industry didn't express any attempt for biomass processing or to make development in that direction (e.g. biogas production). For development in that direction, detailed analysis of existing equipment will be necessary, as well as, the discussion with private owners about their interest to make additional investment. Based on previous experience with private owners of sugar industry and based on information obtained on different workshops and business contacts with the owners, they have the interest to raise the

quality of process production but they need to know the experience of best practice and all economic aspects.

Technical aspects which could be assessed are: type of biomass which could be used in sugar industry, different characteristics of biomass compared to the sugar beet, availability of biomass and distance from collection point to the IBLC or from IBLC to the final user, possibilities for biomass storage according to certain rules to protect the collected biomass from degradation.

2.1.6 Degree of innovation

There is no exact data and information related to the innovation in the Serbian sugar industry. In the last few years, a lot of efforts and improvements were made in energy efficiency. The energy efficiency measures included:

- innovation in evaporators (new falling film evaporators) as a result of which the energy consumption in the Šajkaška sugar factory was reduced by about 20 %;
- certain changes in the steam distribution (insulation of steam distribution lines, valve changes and installation of new instrumentation and control equipment);
- elimination of mechanical problems during the campaign thanks to the newly installed equipment (Pecinci sugar factory). Thus, it can be expected that in the next campaign the energy demand for sugar production will be lower since there will be not discontinuity in the process when all parts of the equipment work properly.

The major problem in sugar industry is coal which is used as main fuel in the process. Actually gas could also be used, but due to the high prices of gas the owners decided to switch to coal. This has led to high environmental problems especially due to the different, mainly imported, coals. It could be expected that due to the environmental legislation, the factories will have to consider to switch to fuels that have less negative environmental impact.

2.1.7 Miscellaneous

Due to the problem mentioned in the previous chapter there is a significant potential for biomass utilization in the sector. For one sugar production generates various biomass by-products which can be used.

Comparable economic and environmental assessment using Life Cycle Assessment method was carried out for raw sugar juice production. In some studies, the advanced raw sugar juice purification procedure, formed as a combination of several purification techniques were examined. Results indicate that modifications contributed to significant decrease in limestone, coke and natural gas consumption which lead to reduced production costs, carbon footprint and cumulative energy demand of raw sugar juice purification. Benefits due to modifications are more pronounced in the years of better sugar beet quality expressed in terms of quotient of purity.

2.2 Opportunities IBLC

2.2.1 Sector related residues

The overview carried out for sugar sector includes also data collection related to biomass residues – quantities and possibilities for utilization. According to the overview of data available, only for Factory "CRVENKA" accurate and updated data is available. This data could be used to estimate of residues in all other factories due to similar equipment and production process. The data for "CRVENKA" factory is presented below.

Sugar Factory "CRVENKA" has the following products:

- Dried shredded sugar beet, pulp pelleted 12x0,8 mm (about 0.38 per one tonne of sugar);
- High-quality molasses (about 0.28 per one tonne of sugar).

Similar quantities are produced in all other sugar factories in Serbia.

It is important to emphasise that MK Group made the first plant for the production of sugar from molasses in Serbia in 2014 in "Sunoko" in Pećinci. MK Group had decided to invest EUR 20 million in the new plant. "Sunoko" currently producing about 80,000 t of molasses this year in its factories, in Vrbas, Pećinci and Kovačica, and it has started to process the molasses in a new plant in Pećinci. This facility is able to use of 80 % of the sugar from molasses that occurs after sugar beet processing [Crvenka, 2018].

2.2.2 Potential synergies & benefits

In Serbia, there is the opportunity for bioethanol production as by-product. Different studies were developed in the last ten years with the intention to develop the scenarios for bioethanol production [CEI, 2012]. In those study, the molasses as a by-product of sugar production is identified, especially as bioethanol among other possibilities that could be used as component for mixing in gasoline. According to the previous reference, the available bioethanol production is 230-310 l /t of molasses.

The utilization of sugar production residues (dried shredded sugar beet) could be also very interesting, as it will improve environmental situation due to reduction of call utilization as main fuel in sugar industry.

2.2.3 Market developments

Today there are seven sugar factories in the Republic of Serbia, whose processing capacity, based on average 100 days of processing, is more than 4 million tonnes. In 2012 the processing capacities of factories that were in operation operated with 65 % capacity (approximately 2.6 million tonne per year of sugar production), but with the trend for rise of sugar production and possibilities for export in the region.

2.2.4 Non-technical barriers

One of the main barriers lies in the fact that three sugar producers operate in this market certainly opens the issue of monopolies.

The abolition of the sugar production quota in the European Union will also affect sugar beet producers in Serbia (sugar quota for Serbia was 181,000 t). According to experts, the abolition will also affect the cultivation of sugar beet in our country. While it is still early for forecasts, some of them believe that solutions could be further stimulation of beet growers through the payment of incentives based on quality. The situation is very delicate and some farmers who for decades have grown sugar beets will not do it in future (in the next 5 years).

Additionally, Serbia has foreign trade arrangement with Russia in the field of agricultural food products, but the protocol that was signed excludes sugar beets. Sugar beets are burdened with a customs duty of USD 300 per tonne, which makes sugar non-competitive on the Russian market.

According to Serbian Chamber of Commerce, the importance of the problem must be taken seriously as the largest part (76 %) was exported to the EU, while the rest went to CEFTA countries, especially due to fact that sugar industry in Serbia is very modern and competitive. Real problems for domestic producers will begin when EU countries that have imported a lot of our sugar stop doing so.

The unresolved relationship and the poor leasing of state land are also the barriers - the issuing of a land for period of one year is too short for achievement of the desired yields and complying with crop rotation. In such conditions, the diseases can easily occur and the soil can be poisoned with residual herbicides and chemicals which for crops such as sugar beet could have an influence on yield and quality. By comparison, the strongest sugar producer in Europe, France has 16 t of sucrose per hectare, 9.1 t are produced in Serbia, and the average in the EU is 11 t.

3 WINE SECTOR

3.1 Profile of the wine sector

3.1.1 Production

The production of wine in Republic of Serbia has a long history, but in recent years it has been raised to a higher level. Wine production consists of a set of operations that make the grapes transform into wine. Harvesting, destemming and crushing of the grapes are the first stage in the production of wine, while in the second stage it is processed and stabilized, i.e. it is suitable for consumption or for storage. The largest volumes are produced as dry wines, in which all sugar is transformed into ethyl alcohol and other (secondary) products. These include white, rosé and red wines of various types and quality. Smaller volumes are produced as semi-sweet wine, in which a certain amount of sugar remains, in addition to the usual amount of ethyl alcohol. Typical schematic process of production of white and red wine is presented on the following Figure 5.

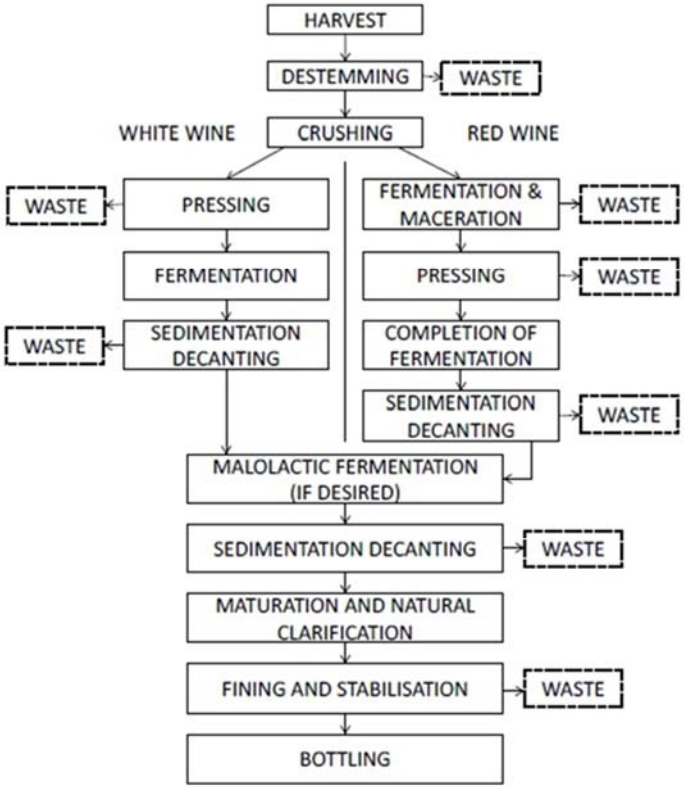

Figure 5. Typical wine production process. Source: Jaksic et al., 2015.

According to presented Figure for usual wine production process, the waste produced are seeds and skin of the grape from the pressing process and waste sludge from sedimentation, fermentation, finning and stabilisation process.

3.1.2 Volume of the sector

According to the collected data from the 2012 Census, wine-growing in Serbia concerned a total area of 22,150 ha (Table 3). It is assumed that today in the entire territory of the Republic of Serbia around 25,000 ha are cultivated with grapevines.

Table 4. Wine-growing area in Serbia. Source: Jaksic et al., 2015.

Wine-growing area in Serbia			
	Area (ha)	Purpose of production	Area (ha)
Central Serbia	17,118	Grape for wine production	17,483
Vojvodina	5,032	Grape for fresh consumption	4,667
Total	22,150	Total	22,150

Regarding vineyard locations there are nine main wine regions in Serbia shown in Figure 6: Timok region (1), Nišava-South Morava region (2), West Morava region (3), Šumadija-Great Morava region (4), Pocerina region (5), Srem region (6), Banat region (7), Subotica-Horgoš region (8) and Kosovo region (9)

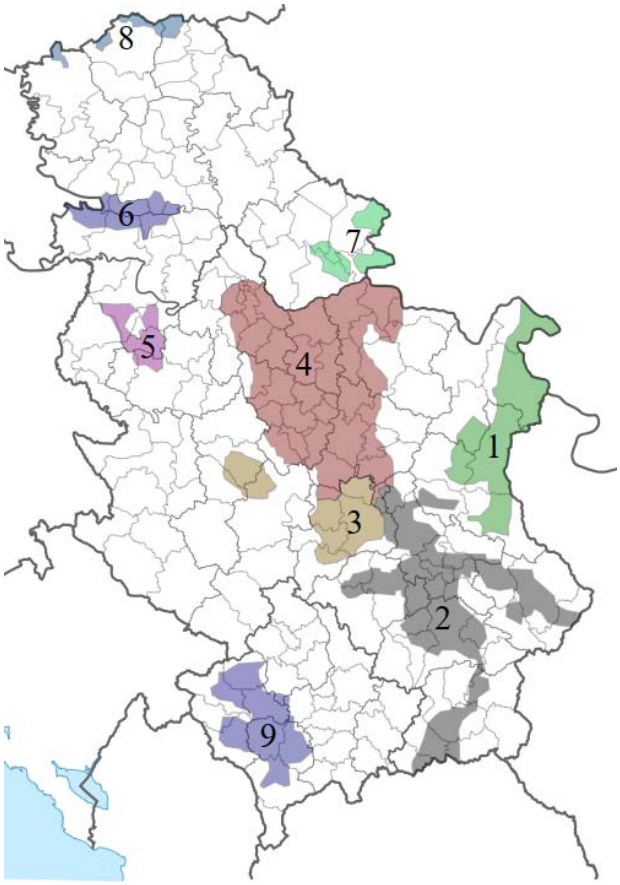

Figure 6. Wine regions of Serbia. Source: Wikimedia Commons, 2017.

Most of the vineyards are within the area of the Three Morava region which is located central and south-eastern part of the Serbia and consists of regions 2, 3 and 4 in Figure 5. At municipality level most of the vineyards are located in Trstenik, town in southern Serbia.

In the Republic of Serbia, 80,341 farms are engaged in the production of grapes, which is 12.7 % of the total number of farms. An agricultural farm that cultivates grapes has an average area of 0.28 ha under grapevine. The average area of vineyard cultivated by a farm in Central Serbia is 0.23 ha, while in Vojvodina the average size of 0.85 ha is significantly higher. Vojvodina is the first region in Serbia which become a member of the association of wine regions of Europe.

Total grape production in Serbia depends of weather conditions during the season and significant deviations can occur from year to year (Table 4).

Table 5. Total grape production in Serbia. Source: Statistical Office of the Republic of Serbia, 2017.

Total grape production in Serbia			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	24,737	193,901	7.8
2007	23,549	191,638	8.1
2008	23,187	216,478	9.3
2009	22,702	240,369	10.6
2010	22,506	171,986	7.6
2011	22,206	193,976	8.7
2012	21,201	149,217	7.0
2013	21,201	199,955	9.4
2014	21,201	122,489	5.8
2015	21,201	170,647	8.0
2016	21,201	145,829	6.9

The last decade was characterized by introduction of new technologies in grape growing and wine production with respect to use of quality and also selected and certified grape variety materials. Selection of varieties, growing of vineyards is the priority and main concern for small winemakers. The way of planting is also changed, suitable for the cultivation of grapevines in smaller, private vineyards. This period of new development is characterized by growing interest among the winegrowers for introduction of organic farming of grapes and production wine.

Grape and wine production technologies are being improved and international trends in wine production are introduced. Quality products are becoming standard but the production volume is still quite limited.

For the period from 2006 to 2016, grape production range was from 122,489 t in 2014 up to 240,369 t in 2009, on almost the same production area. These yield fluctuations are probably caused by cultivation of domestic grape varieties which are not resistant to climate changes.

Production of wine varies from year to year, depending on climatic conditions as mentioned previously. Wine production of producers registered in the Wine Register, is lower compared to official statistics, given that a certain amount of wine is produced for its own needs. Figure 7 presents

the data according the official statistics and wine production of producers registered in Wine register is slightly different as the wine producer is not obliged to be in Wine Register. It is possible to conclude that only 30 % of wine production is originated from wineries with special registration.

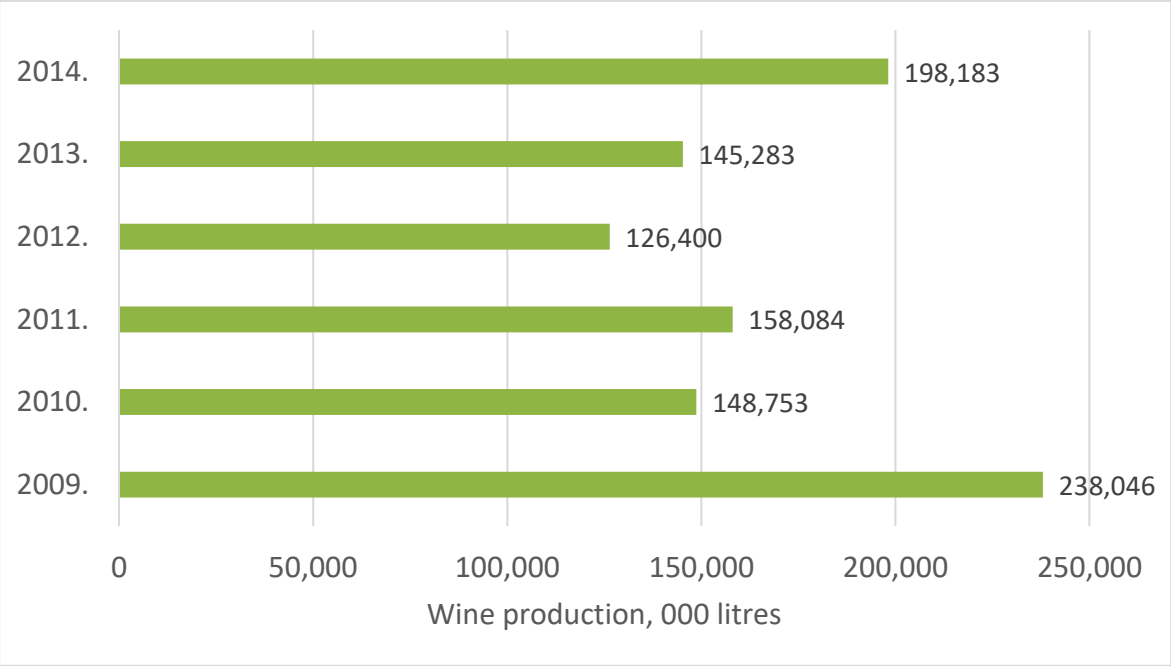

Figure 7. Wine production in Serbia in period 2009 - 2014. Source: Ivanisevic et al., 2015.

It is possible to identify four types of vineyards: 1) small family vineyards of 0.1-0.3 ha; 2) small to medium-sized vineyards that belong to wine grape growers whose focus is on grape production for the commercial wineries—some organized in a cooperative, a few contract growers; 3) modern small-medium vineyards that belong to the wine-makers (integrated firms); and 4) largely older large vineyards of up to 1,400 ha that belong to the industrial wineries. There are an estimated 70,000 farmers with vineyards across these four types. The number of commercial grape vineyards in Serbia is not known, but can very roughly be estimated at being between 6,000 and 24,000.

Based on the data from the Wine Register (January 1, 2014), the number of employees in wineries in Serbia is 3,415 out of which the number of permanent employees is 1,956, and temporary employed persons is 1,459.

3.1.3 State of the sector

In the past few years, the expansion of high-quality wine varieties has started to intensify. The changes in the structure of the assortment were influenced by the adoption in 2005 of the Law on Planting Material, as a result of which the introduction and registration of new varieties and clones was made easier. In addition, subsidies from the Serbian Ministry of Agriculture for raising new vineyard plantations and other positive measures stimulated production. The development of small private wineries and tendency of their founders to produce quality wines also had an impact on positive changes in the grapevine assortment.

In Serbia with production of wines placed on the market, according to the number of producers enrolled in the Wine Register[3] (January 1, 2015), 235 producers are dealing who are exclusively market oriented [Statistical Office of the Republic of Serbia, 2017]. Participation of Serbia in the total world production of wine increased from 0.46 % to 0.80 % from 2006 to 2013. Serbia achieved the largest share in 2010 (0.90 %). In the reporting period, Serbia has recorded a growth of wine production at an average annual rate of 8.63 %.

Table 6. Wine consumption, export and import in Serbia. Source: Statistical Office of the Republic of Serbia, 2017.

Total wine export, import and consumption 2009-2014[4]			
Year	Export (l)	Import (l)	Consumption (l)
2009	10,386,682	21,685,227	27,564,572
2010	10,761,438	29,225,156	24,858,797
2011	15,314,742	32,867,671	23,591,440
2012	22,791,051	33,069,041	22,830,426
2013	11,477,712	23,492,456	18,246,913
2014	11,941,522	31,733,782	NA

Based on the presented data, it can be concluded that the import of wine is two times higher than the export. The largest part of both exports and imports is from the CEFTA countries, while the respective share of EU countries is about 10 % for imports and 5-10 % for exports. Wine consumption is yearly decreasing, so in 2013 it was 30 % lower than in 2009 referring to data presented in Table 6.

3.1.4 Typical size of the companies

According to the data from the Wine Register (January 1, 2015), the number of large winery in Serbia with more than 250 employees is small, i.e. only two wineries, and in a group of wineries with 50 to 250 employees is an only one winery, although measured by their share in the total volume of produced wine they have a large share in production. In Serbia there are 23 medium wineries, with 10 to 49 employees. Small wineries, with less than 10 employees, make up for the largest group of wine producers in Serbia (191).

There are three types of wineries in Serbia:

– Industrial/corporate producers (Vršac vineyards with about 1,700 hectares of plantation, Navip from Belgrade and Rubin from Krusevac have about 700-800 hectares of vineyards) - operate on a large scale with large vineyards, processing facilities, and storage rooms - these

[3] Wine Register is a database held by the Serbian Ministry of Agriculture of wine producers, wineries, and other data in accordance with Serbian Law on Wine [Official Gazette of the Republic of Serbia, 2009].

[4] The data in Table 6 present the volumes of the wine producers that are registered in the Wine Register. Because wine producers in Serbia are not obligated register themselves in the Wine Register and not all producers have been inclined to do this, these data do not represent the entire Serbian, whereas the data in Figure 6 do present the total amount of wine produced in Serbia.

are the privatized former state enterprises, which were focused on quantity and price only. Quality was low. Most of these processors are still struggling with this inheritance, suffering from bureaucratic management, operational inefficiencies, and quality issues. Modern technologies and marketing strategies are largely absent. These wineries also produce about 8 million litres per year of cognac distillate.

- Medium-sized wineries that produce wines in the high-end and premium segments - all of them are family managed, but with some hired employees. There is some heterogeneity in this group. Their intentions are to grow to around 500,000 litres per year and then stay at this level, which they consider as the limit of a winery managed as a family business. Rather than increase scale, they would focus on increasing quality. This group probably has the potential to grow from the current 3 million litres to about 5 million litres over the next five years. Although they currently only represent less than 10 percent of the market in volume terms, they represent an estimated 20 percent of the market in value terms.
- Third are small wineries, each producing a volume of 10,000 to 80,000 litre per year. Their combined output is estimated at around 1 million litres annually. These wineries are 100 percent family run (no hired employees), quality focused, and just getting into commercial production and sales. A significant part of their production is of a slightly lower quality wine sold in bulk from the winery to customers in the region.

It is very difficult to make a strict classification of wineries according to their size. In some cases, the production capacity of wineries isn't the key parameter for classification. The other important parameters are the quality of wine number of full time employs and the type of selling and distribution. For example, the medium wineries should be presented in average production capacity of 30,000, maybe even 20,000 litres per year. Some of the best-quality wineries (for example Janko, Jeremic, Despotika, Jovic, Vindulo, Belo Brdo) are in the production of about 50,000 litres per year. They have full-time employees, do not sell in bulk, they are recognized for the quality and not quantity, although they fit into the description for the medium size and should not be associate in the group of small producers.

3.1.5 Distinctive facilities of the sector

Viticulture zoning divides the territory of Serbia into three wine growing units which comprise 22 regions, 77 wine growing districts and a large number of wine growing oases. Domestic market has developed in last ten years, especially regarding the number of private wineries. A lot of investment was made in winery sector, especially in growing new areas under the grape, as well as, in new capacities for wine production.

Development of wine production will be also followed with development in distilleries development which could represent an opportunity for IBLC implementation. This opportunity will be interesting especially for medium-sized wineries due to the interest they have showed for modernization and application of good and modern practices.

IBLC could be the part of modernization process of industrial/corporate producers, as they started with some activities in planning and realization of modernization. One of them is RUBIN, a company founded in 1955 and privatized in 2005. With the new owner, Rubin has gone even further with the

trend of developing new products and investing in the improvement of the production process, all in order to improve the quality of their wines. According to the information obtained directly from Rubin, in addition to viticulture, numerous investments have been made that have contributed to a significant improvement in the technological process of wine and strong alcoholic drinks production: as for example a new line for cold - aseptic filling of wines, for which a new pneumatic presses was installed and many other investments that have greatly contributed to the improvement of the production process and improving the quality of the wine.

3.1.6 Degree of innovation

Over the last few years, there was a significant progress in improving technologies for viticulture and oenology and in improving wine quality and production of wine with geographical indication. This is proved by the fact that the export of qualitative wine with geographical indications has risen recently.

A large number of measures have to be taken at different levels in order for Serbian viticulture to be renewed and intensified. Although subsidies given for viticulture and oenology are among the largest subsidies in the region, the government should continue providing support for new vineyard establishment, clone selection and certification as well as for the introduction of new modern technology. The producers have to change their habits; they have to cooperate (especially because of the label for geographical indications) and broaden knowledge and improve technologies. National scientific and research work has to be supported and developed.

Official data about degree of innovation are not available, especially related to biomass utilization. Comparing to all other innovation in this sector, the knowledge about the innovation related to biomass is very limited. It could be expected that with the interest for biomass will increase due to interest of make much more efforts in the area of sustainable wine production.

RUBN performed all developing activities in continuity of an idea of developing process and all that resulted in improved technology and quality of RUBIN'S products. Some attempts in biomass utilisation for energy purposes are made at RUBIN. Biomass collection (pruned branches) is organized and it is used in boilers installed within the factory. The opportunity for biomass utilisation is based on large vineyards and large quantity of biomass residue.

3.1.7 Miscellaneous

Serbia has very favourable climatic and soil conditions for grape growing, but wine sector could be much more developed. The main limiting factors for grape production in Serbia are very old plants, which should be renewed and for this a significant investment is needed. It is estimated that more than half of the vineyards are older than 30 years [Milić et al., 2016]. Another reason for the decline is that family farms are bearers of wine production, while big agricultural enterprises are significantly smaller manufacturers. Small plots prevent the use of productive machines and performing the necessary agro technical measures.

3.2 Opportunities IBLC

3.2.1 Sector related residues

According to the investigation related to biomass potential in Serbia, the pruning of vine yields is from 4 up to 8 t/ha of vineyard. This data is important because of the significant area covered with vineyards - about 22,000 ha in Serbia. Based on this data the total biomass residues from grape growing could be estimated at about 170,000 t/year, with average heating value of 12 MJ/kg the energy potential of biomass residues from grape is about 50,000 toe[5]. The energy potential of vine pruning residues alone is about 55,000 toe.

According to information obtained directly from producers, there are no specific data related to the amount of waste after the production of wines (stems, grapes and seeds). After conversation with several respondents (winemakers), average data were provided related to percentages depending on the grape variety and the way of processing. In the production of quality red wines, the amount of waste biomass is 30-40 % of the total weight and in white and rosé wines 40-45 %. Unfortunately, these data are not official but used by wine producers at the stage of production and storage planning of both products and waste biomass, which is unfortunately unused. Collecting the most recent data from the agricultural register and other services related to this topic is in progress. Collected data will include both in the production of wines and in other agricultural production in the municipality of Aleksandrovac and the possibilities of their use.

Regarding economic cost-effectiveness of biomass utilization, IBLC can only be interesting for the largest wineries (where besides large wineries from the first category it will be added from the other Kovačević, Aleksandrović and Radovanović, possibly also the Toplič vineyards). The collected stocks have small bulk density and the costs of transport in a freshly collected state for the purpose of joint processing of the producer group at one location would be astronomical (for example, the collected cropped holders from 4 lines, which is about 300 plants, will add 1m^3, corresponding to a total mass of only 30 kg). The only solution seems to be to collect and utilize onsite. However, due to the cost of the equipment, only big facilities could be eligible. Remnants of fermentation (pulp, flakes) contain a high moisture content and with heterogeneous quality and high quantity of energy is necessary for drying comparing with the energy that could be produced.

In the wineries, there is no need for heating, except for hot water. On the contrary, there is a need for cooling. Therefore, any briquette from the residues could only be a produced for the market.

[5] Tonne(s) of oil equivalent, abbreviated as 'toe', is a normalized unit of energy. By convention it is equivalent to the approximate amount of energy that can be extracted from one tonne of crude oil. It is a standardized unit, assigned a net calorific value of 41 868 kilojoules/kg and may be used to compare the energy from different sources [EUROSTAT, 2018]

3.2.2 Potential synergies & benefits

Biomass residues obtained from grape grown and wine production are heterogeneous and composed of stalks, grape skins and seeds. In previous year, some initial investigations have been done related to the physical-chemical characteristics of each single component of grape residue and influence of grape marc on examined characteristics. The intention of this characteristics was to investigate the possibility of an energy and industrial utilization. In addition, a mechanical extraction test on the seed was performed to evaluate the oil production from grape seed and the characteristics of the cake. 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.

The interest for IBLC in wine sector exists. The main reasons for relatively low biomass utilisation lie in lack of adequate equipment for biomass collection and relatively small vineyards area. There are some idea and attempts for biomass collection and joint procurement of the necessary equipment by several small producers. Small wine producers insist in the organization in alliances, which will be responsible for further development, and organization for procurement and utilisation of the new equipment for different activities. In the same time, they are interested for making the connection with biomass from fruit production and its utilisation.

Wine sector should be also related with the brandy and fruit juice industry. Several producers for years have been using apricot plum and peach that they receive free of juice and brandy processors in briquettes. This is for them waste and they were earlier paid to take it away. Drying in air for one year is sufficient to be usable as a fuel without further processing.

3.2.3 Market developments

Wine sector has a lot of opportunities for further development: there are lot of potential for improved quality, lower price on the domestic market and bigger export to other markets. According to a USAID project, five important activities were identified for further market development [USAID Belgrade, 2012]:

- Foreign Direct Investment – Strategic Partnerships at the Industrial Winery Level
- Promotion – Develop Image, Consumer Knowledge of Wines, Wine Regions, and
- Indigenous Varieties
- Good Agricultural Practices at the Grape Grower Level – Expand/Build High-Quality Wine Grape Base
- Small Wineries, especially in Rural Areas – Improve Quality of Equipment, Knowledge and Market Access
- Image Building by Medium-Sized Wineries – International Competitions.

Based on detailed analysis of actual situation and Bilateral Screening of Republic of Serbia for EU accession (Negotiating Group 11 - Agriculture and Rural Development), the following activities have been identified as most important for upcoming period [BOŠ, 2014]:

- Continue the harmonization of legislation (Geographic information service certification bodies, authorisation, rulebooks, and rulebook for aromatized wine)

- Set up professional program (software) for Vineyard Register and techniques
- Set up a professional program (software) for Wine Register
- Set up a professional program (software) for Winery records
- Support wine producers to prepare studies /examination (for product specification)
- Set up Wine Balance Sheet for better statistical data collection
- Improving knowledge in viticulture and wine production, including possibilities for energy efficiency and biomass utilization
- Improvement of producer organizations
- Viticulture mezo zoning (plans for future activities: potential vineyard locations and potential organic vineyard locations) and set up centres for wine variety testing /education
- Set up laboratory system for isotopic analysis and isotopic data bank
- Continuation of support (subsides) for grape (planting new vineyards), wine plant production (certification and clonal selection) and wine production

3.2.4 Non-technical barriers

Wine production costs are high, material and labour costs have a dominant share in total costs up to 85 % [Milić et al., 2016.]. In the analysed period (2012-2014), the largest share was accounted by material costs with an average of 34 %, most of which is the usage of NPK fertilizer, costs of plant protection (herbicides, insecticides and fungicides) and then other material costs. Average cost of wages was 30 %, due to high labour requirements, especially in matters of pruning and harvesting. In addition to these, costs of services accounted for 19 % of total costs.

One of the most essential changes required in the Serbian wine value chain is the expanded use of long term contracts for wine grape supply. Mutually rewarding, legally binding contracts must be negotiated in advance between grape growers and wineries. These contracts need to take into account any regulatory requirements regarding land use and will form the basis for long-term relationship building related to high quality and fair prices for both parties. For growers, contracts help secure a market for their output, and for wineries they secure a supply of a quality wine grape product, customized to the specific needs of the winery. These contracts should indicate practices to follow (pruning, harvesting, transport, and so on), quality standards to achieve, quantity to produce, price to sell at (based in part on lab analysis, with a minimum price), payment terms to comply with, cleanliness of the product, and so on. Quality relates to yield (5-9 t/ha), pest management practices, and agreed-upon ripeness measurements. Price can be set per metric tonne or per hectare. In the latter case, the winemaker shares the risk with the grower (with a minimum cap) and risk is minimized (as is the profit potential). These contracts may be set up for a year or for multiple years. For example, contracts made with larger wineries with larger economic resources could provide or facilitate financing for planting blocks of new vineyards linked to 15-year contracts.

Horizontal linkages among grape-growers and winemaker associations are weak. Serbian wineries are very individualistic in nature and for the greater part do not have the financial resources to contribute to a joint industry promotion fund.

There is a problem with plant disease (vine yellows), and plant protection and inspection are ineffective. Irrigation is largely absent in vineyards and methods for vineyards management, including fertilization, are outdated. The necessary mechanization for efficient, high-quality grape

growing is missing or obsolete in most cases. In addition, the cost of establishing a vineyard in Serbia is high. In combination with a higher labour cost, the above factors negatively influence the competitiveness of Serbian producers in relation to their counterparts in the region.

Equipment for harvesting and collection is outdated and there are no resources to upgrade equipment and to improve winery operation and its efficiency. Adoption of modern techniques, technologies, and equipment is rare. There is no recovery of value from winery wastes, nor is there a waste management system in place in most of the wineries.

4 VEGETABLE OIL EXTRACTION

4.1 Profile of the vegetable oil extraction sector

4.1.1 Production

The most important plants that are cultivated in Serbia for vegetable oil extraction process are rapeseed, sunflower and soybean. The vegetable oil extraction process (Figure 8) comprises three parts:

- Preparation of oil crop grain (cleaning, drying, storing)
- Separation of oil from the grain (peeling, hulling and pressing of the grain, extraction, water degumming of the raw oil)
- Refining of the oil.

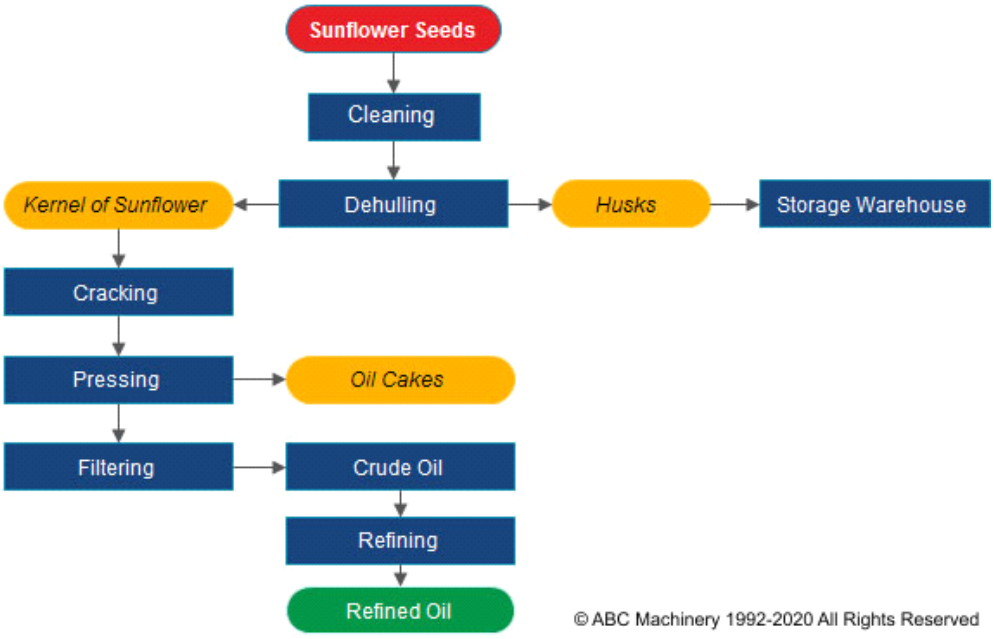

Figure 8. The vegetable extraction oil process. Source: http://www.abcmach.com/, 2018.

Further refining process consider following techno-chemical treatment:

- Degumming – removal of phosphatides, waxes and soaps
- Bleaching – removal of pigments, metal ions and remaining soap and peroxides,
- Winterisation –removing residual waxes if they come through the bleaching phase
- Deodorisation – removal of undesirable smells and tastes, as well as most FFAs (free fatty acids) from the oil, though a vacuum distillation procedure with the addition of direct water steam.

The oil content of the dry rapeseed grain is 40-47 %, and the protein content is 19-29 %. In the rapeseed grain there are also harmful substances: glucosinolates, eruca fatty acid, phytins and tannin which are not used as by-products.

4.1.2 Volume of the sector

The vegetable oi extraction sector is well developed in Serbia and accounts big tradition. Different feedstocks are used for oil extraction: rape, sunflower and soya. This sector is known as a sector with modern equipment and high quality products.

Rapeseed

In Serbia, rapeseed production has been marginally grown, covering not more than 0.7 % of total arable land during previous decades. In 2007, the growth of rapeseed production was caused by opening a biodiesel plant in Šid (Victoria Oil). According to the last Census of Agriculture 2012, the rapeseed is produced only by 319 farms (Statistical Office of the Republic Serbia, 2012).

The yield of rapeseed improved significantly in recent years, thanks to new hybrids with yields of 5-7 t/ha. The agro ecological conditions of some years can affect the yield, especially drought in the sowing period (as happened in 2011). The poor organization during the sowing period of rapeseed, as well as the uncertainty regarding yields and revenues, contributed to the fact that this culture in Serbia has not yet significantly increased.

Table 7. Total rapeseed production in Serbia. Source: Statistical Office of the Republic of Serbia, 2017.

Total rapeseed production 2006-2016				
Year	Production area (ha)	Production (t)	Yield (t/ha)	Export (t)*
2006	3,873	7,595	2.0	NA
2007	12,943	29,825	2.3	NA
2008	17,996	51,907	2.9	NA
2009	18,091	44,300	2.4	NA
2010	12,012	24,399	2.0	NA
2011	15,357	44,531	2.9	NA
2012	8,258	20,076	2.4	NA
2013	9,686	26,992	2.8	NA
2014	9,815	31,419	3.2	NA
2015	12,226	33,402	2.7	NA
2016	13,476	39,404	2.9	NA

*Data are not available

Sunflower

In Serbia, over 150,000 ha are sowed with sunflower, equalling about 5 % of arable land. According to Census of Agriculture 2012 – Agriculture in the Republic of Serbia, the major part of this areal (94 %) is in Vojvodina. Sunflower crop is mainly grown on agricultural farms (74 %). According to Census of Agriculture, sunflower was produced on 28,307 farms, of which 28,046 are family farms and 261 are legal entities. Farms which produce sunflower are predominantly located in Vojvodina (23,893). The majority of sunflower producers are farms with size of 5-10 ha. The largest area (35.54 % covered

with sunflower) is cultivated by 980 agricultural holdings which constitute only 3.46 % of the total number of agricultural holdings producing sunflower. In sunflower production, Serbia is on the tenth place in Europe, and per yield per hectare seventh in the world.

Table 8. Total sunflower production and export in Serbia. Source: Statistical Office of the Republic of Serbia, 2017.

Total sunflower production and export 2006-2016				
Year	Production area (ha)	Production (t)	Yield (t/ha)	Export (t)
2006	186,431	384,945	2.1	6,000
2007	154,793	294,502	1.9	18,000
2008	187,822	454,282	2.4	10,000
2009	157,337	377,549	2.4	2,000
2010	169,384	378,409	2.2	16,000
2011	174,270	432,020	2.5	17,000
2012	185,918	366,020	2.0	52,000
2013	188,189	512,839	2.7	103,000
2014	175,366	509,250	2.9	76,000
2015	166,192	437,084	2.6	133,000
2016	200,299	621,127	3.1	124,000

The production in 2016 was about 621,127 t, i.e. 3.1 t/ha, which is above the annual average (around 2 t/ha). Of this amount of sunflower seeds 283,000 t up to 319,000 t of oil should be produced depending of oil content in the seed, given that the annual demand of Serbia is about 80,000 t. Total capacity of sunflower oil production is 788,000 t/year or soya oil production – 625,000 t/year or rape oil production – 530,000 t/year. The largest sunflower processing and oil production capacities are: "Vital" Vrbas (22 %), "Dijamant" Zrenjanin (27 %), "Victoria oil" Šid (23 %), "Sunce" Sombor (15 %), and "Banat" Nova Crnja (13 %). In 2016, total domestic oil consumption for food was 82,000 t and 117,000 t were exported to the other markets.

Soybean

The average area in Serbia sown for soybean production is 160,000-180,000 ha, with the tendency of constant growth. Soybean cultivation is becoming more and more profitable, and in Serbia part of the sunflower cultivation is already substituted by soybean. The average yields range from about 2.5 to 3.5 t/ha, which is higher than the world average. This soybean is mostly sown in Vojvodina. According to Census of Agriculture, the soybean was produced on 35,246 farms, of which 34,934 were family farms and 312 are legal entities. The largest area covered with soybean (52 %) is cultivated by the farms with size 50 and more hectares.

Table 9. Total soybean production and export in Serbia. Source: Statistical Office of the Republic of Serbia, 2017.

Total soybean production and export 2006-2016				
Year	Production area (ha)	Production (t)	Yield (t/ha)	Export (t)
2006	156,680	429,639	2.7	2,000
2007	146,988	303,950	2.1	1,000
2008	143,684	350,946	2.4	2,000
2009	144,386	349,193	2.4	5,000
2010	170,255	540,859	3.2	83,000
2011	165,253	440,847	2.7	18,000
2012	162,714	280,638	1.7	25,000
2013	159,724	385,214	2.4	23,000
2014	154,249	545,898	3.5	95,000
2015	184,841	454,431	2.5	57,000
2016	182,362	576,446	3.2	95,000

The processing plant “Sojaprotein” in Bečej is the only soybean processing plant in the Balkans. This company is part of the "Victoria Group", one of the largest and most modern vegetable oil processing industries in Europe. “Sojaprotein” is the largest contractor for soybean production in Serbia, followed by “Diamond”, “Invej” and a number of other processors. Serbia is one of the main producers of oil from soybeans in Europe. From the total soybean production of 576,000 t in 2016 50,000t were exported. All produced soya concentrate for feed and fodder production is placed on the world market.

The main vegetable oil extraction facilities in Serbia presented on Figure 9 are:

- Victoria Oil as a part of Victoria Group, located in Šid (1)
- Company Dijamant AD, located in Zrenjanin (2)
- Vital AD, located in Vrbas (3)
- Sunce AD, located in Sombor (4)
- Sojaprotein as a part of Victoria Group, located in Bečej (5)
- Banat AD, located in Nova Crnjaj (6)

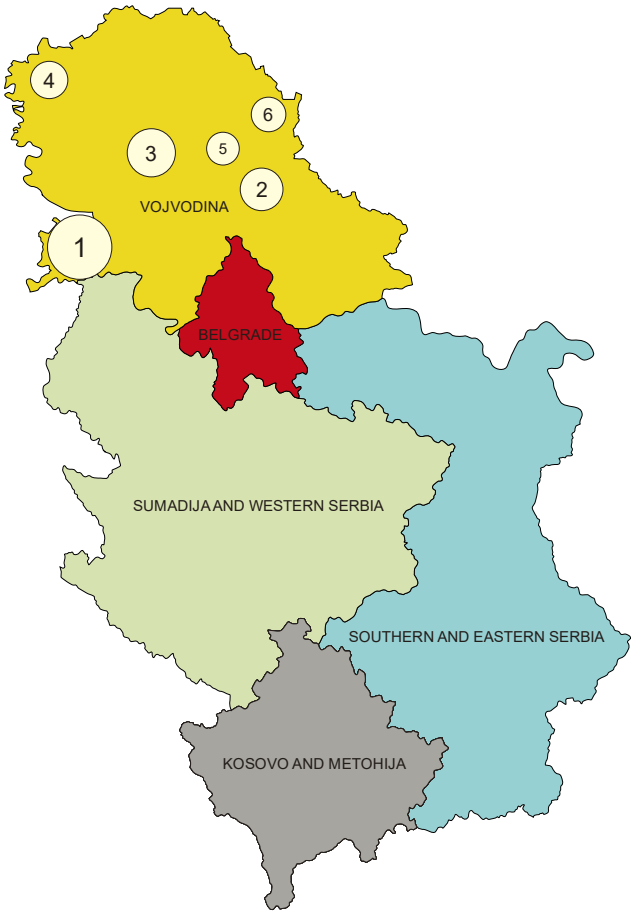

Figure 9. Main vegetable oil extraction production facilities in Serbia. Source: Hickingbottom & Jackson, 2013.

4.1.3 State of the sector

As one of the largest oil producers the Republic of Serbia is also the country with the largest processing capacities in the CEFTA[6] area. The Serbia's vegetable oil extraction industry has a capacity for the annual processing of 885,600 t of sunflower seeds, 482,000 t of soybeans and 247,000 t of rapeseed. However, in the Republic of Serbia the average processing level of sunflower processing in the past ten years was only 40 % of the available capacities, and of soybean at 70 %. The quality of the raw material and the prospective market (primarily in the soybean processing sector) open up the capacity for more efficient use of capacities. Oil consumption is presented in Tables 10 and 11. Consumption of sunflower oil for food use is practically constant and has not changed over the years and participates with about 40-45 % (average 46 %) in total consumption with minor changes resulting from changes in total oil consumption. Export of sunflower oil in the last 10 years has grown and from 25 % of total sunflower oil consumption it reached the value of more than 50 % (average 41 %). A completely different picture is with the soybean oil consumption. Soybean oil is dominantly

[6] CEFTA - Central European Free Trade Agreement, As from 1 July 2013 the parties in the CEFTA agreement are: Albania, Bosnia and Herzegovina, Macedonia, Moldova, Montenegro, Serbia and Kosovo (as UNMIK)

exported (average 52 %) and a smaller part is used at national level for food preparation (average 33 %).

Table 10. Sunflower oil consumption in Serbia 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total sunflower oil consumption in Serbia 2006-2016					
Year	Food use (t)	Other use (t)	Export (t/ha)	Closing stocks (t)	Total consumption (t)
2006	82,000	31,000	45,000	19,000	177,000
2007	82,000	7,000	48,000	5,000	142,000
2008	82,000	7,000	48,000	11,000	148,000
2009	82,000	9,000	83,000	15,000	189,000
2010	76,000	8,000	59,000	15,000	158,000
2011	76,000	8,000	80,000	23,000	187,000
2012	76,000	6,000	93,000	1,000	176,000
2013	76,000	6,000	86,000	3,000	171,000
2014	76,000	6,000	64,000	33,000	179,000
2015	76,000	6,000	64,000	21,000	167,000
2016	76,000	6,000	117,000	8,000	207,000

Table 11. Soybean oil consumption in Serbia 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total soybean oil consumption in Serbia 2006-2016					
Year	Food use (t)	Other use (t)	Export (t/ha)	Closing stocks (t)	Total consumption (t)
2006	48,000	1,000	21,000	10,000	80,000
2007	17,000	1,000	41,000	1,000	60,000
2008	41,000	1,000	28,000	7,000	77,000
2009	22,000	1,000	43,000	15,000	81,000
2010	24,000	1,000	45,000	10,000	80,000
2011	24,000	1,000	49,000	7,000	81,000
2012	24,000	1,000	31,000	10,000	66,000
2013	24,000	1,000	31,000	25,000	81,000
2014	24,000	1,000	59,000	18,000	102,000
2015	24,000	1,000	58,000	12,000	95,000
2016	24,000	1,000	69,000	1,000	95,000

4.1.4 Typical size of the companies

Vegetable oil extraction is manufactured in 6 factories among which Sojaprotein is part of Victoria Group and focus only in soybean processing. As the main producers of vegetable oil and their market share are presented in the previous chapter 4.1.2 and Figure 7, detailed description of the companies will be given bellow.

In this sector, the most important engagement is of the company "Victoria Group", which has contributed much to better sowing organization. By engaging agricultural engineers a number of agricultural producers have been trained, which is one of the most important requirements for accepting cropping system. Four years ago growers sowed up to 20 kg of seeds per hectare and today 2.6 kg/ha. Soil preparation was improved, seed protection from insects, and last year 99 % of surfaces did not need to be treated with pesticides. By applying scientific achievements new hybrid varieties have resulted in increased yields, so the pods do not open under the influence of rain and wind. Harvesting machinery has also been improved.

Victoriaoil's core activity is the production of unrefined and refined oils, biodiesel and protein meals. The primary activity of the company is the production of raw and refined vegetable oils, biodiesel and protein meal. Currently, the factory processes almost 220,000 t of sunflower and over 85,000 t of soybean annually, and the processing technology allows complete flexibility of the oil crop refining production process. Victoria Oil also has a cutting edge plant for bottling and packaging edible oil with a capacity of 12,500 litres per hour. In 2009, a modern filling and packaging plant for sunflower oil was launched when Victoriaoil's most famous brand – the edible oil Iskon – was first created. With a capacity of 14,000 litres per hour, the annual production exceeds 68 million bottles of edible oil. Excellent results were achieved not only in the local market, where Iskon's share is 30 %, but also in Austria, Slovakia, Slovenia, Hungary, Greece, Croatia, Bosnia and Herzegovina, Montenegro, Macedonia and Albania. Total number of employee is 305.

The company Dijamant AD is the largest producer of edible oils in Serbia. With a strong distribution network of distribution centres in Belgrade, Nis, Cacak, Vrbas and Zrenjanin the company covers the entire Serbian market as leading manufacturer of margarine, vegetable fat, mayonnaise and delicacy products based on mayonnaise. In addition, Dijamant produces also ingredients for other food industry, especially for the confectionery and bakery industry. Total number of employee is 732. The company is also an important factor in the agricultural sector, particularly in the production of oilseeds, which includes the development of partnership relations with agricultural producers, as well as the development of logistics coverage for the purpose of purchase and a modern, safe storage of the oil crops. In cooperation with more than 400 suppliers Dijamant, has been actively involved now for decades in the organization of production of sunflower and soy in Serbia. Today Dijamant is one of the largest single purchasers of oil plants in Serbia, with an average of purchased 250,000 t of raw materials annually.

Vital is one of the largest and oldest factories of oil and vegetable fats in the Balkans. After its privatization in October 2005 Vital became part of Invej Corporation and continues its role as an undoubtedly important actor. With the advancement of technology, the application of new business models and the development of a wide range of products intended for the most demanding consumer tastes, Vital has managed to meet the expectations of not only domestic but also foreign. Changing the way of life, new research in the field of human health and its direct connection with nutrition, are the basic guidelines that lead the development team of Vitala when creating new products. Total number of employee is 334.

This company's recognisable consumer brand is Iskon, which is an edible sunflower oil of the highest quality, with more than 70 million bottles produced per year. Exceptional results have not only been

achieved in the local market, in which Iskon has a share of up to 30 %, but also through exports to Austria, Slovakia, Italy, Holland, Slovenia, Hungary, Greece, Croatia, Bosnia and Herzegovina, Montenegro, Macedonia and Albania.

Processing capacity:

- 1,200 t sunflower a day
- 750 t soybean and rapeseed a day

Production capacity of the flexible refinery plant is 300 t refined oil a day.

Capacity of the filling station – edible oil bottling plant is 12,500 bottles an hour

Warehousing capacities:

- Universal silo with three kilns for storage up to 40,000 t sunflower seeds or 70,000 t soybean or 80,000 t wheat grain
- Universal storage for all types of seeds and meal with a capacity 50,000 t
- Protein meal storage with a capacity of 1,000 t
- 17,000 m^3 storage for sunflower husks

The major activity of the factory Sunce Sombor includes processing of all sorts of oleaceous plants, crude edible oil production, production of packaging for own purposes, industrial herbs drying for own purposes etc. Every year, the production program is expanding, capacities are enlarging and production technology is improving. Total number of employee is 170.

Oil factory "Banat" AD is company for the production of vegetable oils and fats, press cake and meal. In the factory are processed sunflower seed (including high olenic type seeds), soybean, rapeseed, and pumpkin seed. The product range includes sunflower edible oil known under the brand The Cvet Banata, and assortment of cold freshly squeezed oil. The Banat AD products are oils from seeds of soybean, rapeseed and sunflower seeds high olenic Olivko type, and meal with various percentages of protein. Total number of employee is 166.

4.1.5 Distinctive facilities of the sector

Vegetable oil industry is located in the North part of Serbia, in Vojvodina. The total capacity is higher than needed. Oil production industry has made significant investments in modernization and equipping, both in large and small capacities for the production of cold-pressed oil in the last ten years. As one of the largest oil producers in the region, the Republic of Serbia is also the area with the largest processing facilities in CEFTA countries.

The good example of modernization and interest for biomass utilization is Victoria Starch, the youngest member company from the Victoria Group business system, which began continuous production of agro-pellets, i.e. pellets from agricultural biomass, in mid-2013. Among others, Victoria Group started to invest in renewable energy sources, especially biomass for energy purposes (Table 12). Victoria Group is currently the only system in Serbia which can adequately respond to the aforementioned challenges, and manages large quantities of biomass thanks to its network of long-time partners, purchase of straw, and organisation of storage in the company system, the use of advantages of its own logistics structure and investing into the pelleting plant. As part of the Victoria

Group system, Victoria Logistics, with its logistics network (12 silos in its ownership, a port on the Danube, transport and handling) has all the preconditions for the efficient collection and management of biomass in the area of Vojvodina.

The company (Victoria Logistics) owns significant storage capacities – silos with a capacity of 200,000 t, while an additional 650,000 t of various types of goods are stored in external storage facilities. The total volume of transport facilitated by Victoria Logistic exceeds 2 million tonnes per year.

Table 12. Biomass utilization plants in vegetable oil extraction sector in Serbia. Source: Victoria Group, 2017.

Biomass utilization plants in vegetable oil extraction sector in Serbia			
Description	Year	Fuel	Capacity
Boiler, Victoria oil	2006	Sunflower husk	15 t/h, p=12 bar
Boiler, Sojaprotein	2009	Straw (bale and pellet) and soya husk	15 t/h, p=12 bar
Boiler, Victoria oil	2013	Sunflower husk	24 t/h, p=13 bar
Pellet production	2013	Straw	4 t/h

In two other vegetable oil factories (Dijamant, Vital and Banat) similar activities were done:

- Construction of new boilers using biomass residues from production process (sunflower husk and oil waste)
- Switching fuel from fossil to biomass (sunflower husk).

The investments in those facilities are much lower the investment made in Victoria Group System.

4.1.6 Degree of innovation

In the oil production sector, significant investments in modernization and equipping were made, both in large and small capacities for the production of cold-pressed oils.

In the past years several modifications were made and investments were done to improve the Banat oil factory's performance:

- Reconstruction of the plant's extraction section with new equipment - improvement of the quality of the meal and increased capacity with more than 20 %.
- Increasing of the pressing capacity for 43 % with the new equipment.
- A new packaging line for 1 litre PET bottles for vegetable oil with a capacity of 6,000-8,000 units per hour.
- A new water treatment plant which provides good quality water for the boiler plant.
- Construction of a wastewater treatment plant.

4.1.7 Miscellaneous

As industry with a big tradition in Serbia, the vegetable oil producers developed very good cooperation with farmers and make a lot of efforts to upgrade it. One of the examples is Victoria Logistic which has the cooperation with around 40,000 farmers through more than 300 co-operatives, insuring necessary intermediate goods and providing advisory services to partners. Through this network, Victoria Logistic organize the purchase of biomass: soy straw, wheat and corn, as well as the production and sale of biomass pellets.

Serbia has very favourable climatic and soil conditions for growing plants that are cultivated for vegetable oil extraction. The main limiting factors are cooperation needed among numerous farmers, necessity of advisory service to support them and significant financial investments.

4.2 Opportunities IBLC

4.2.1 Sector related residues

Residues from the vegetable oil extraction sector, like sunflower husk or residues from oil extraction process (oil waste), are mainly used within facilities for production energy for own use.

Vegetable oil industry in Serbia has a lot of experience with sunflower husk processing. In the previous period (some decades ago), it was used for different purposes:

- fuel (briquettes for household heating or as a fuel for industrial boilers),
- cattle food (grind grain, very low protein value - below 5 %),
- additional material for crushed sunflower seed (grind),
- mulch for cattle.

Today, sunflower husk is dominantly used as a fuel in industrial boilers which are designed and constructed for combined firing of natural gas, medium oil and/or waste liquid residues from production process of edible oil (and margarine).

As mentioned before, Victoria Logistic uses obtained residues for production of biomass pellets. The whole production of pellet is utilized in the company for energy production and not sold to the market.

Victoria Logistic is also engaged in the purchase of biomass – soybean, wheat and barley straw and cornstalks. The transformation of production residues into bio-energy not only ensures the energy independence of most of the Victoria Group factories, but also the reduction of harmful emissions.

Additionally, Victoria Group has been pre-financing primary agricultural production with average annual amounts exceeding EUR 100 million, as a form of support for farmers to try and ensure successful harvests. Thanks to its wide network of partners in the primary agriculture sector, as well as its processing capacities, the company currently purchases raw agricultural products covering 200,000 hectares across Serbia - which directly benefits approximately 100,000 people in various local communities. This successful cooperation with farmers could be good practice for other companies and different agriculture sectors. In future, development of agriculture sector is not possible without consolidating and organizing the farmers, especially in the conditions that exist in Serbia where individual farms are relatively small.

4.2.2 Potential synergies & benefits

The oil production capacity in Serbia is too dimensional and can partly be used to supply plants for the production of biodiesel by raw materials. Several studies and projects were developed with the intention to examine also the possibilities of their partially integration of production of biofuels, especially of next generation biofuels.

Good experience from Victoria Group factories could also be implemented in other companies in vegetable oil industry.

4.2.3 Market developments

The vegetable oil industry as well developed makes constant efforts for further development. They have plans and strategies for further investment in energy efficiency and biomass. With good network with farmers, vegetable oil industry annually invests significant funds through the pre-financing of primary agricultural production and gives support to farmers by providing inputs and free soil analysis.

4.2.4 Non-technical barriers

In Serbia non-technical barriers could be identified as follows:

- Biomass is mostly found in the area of Vojvodina, but its use is modest (around 2 %).
- Small farm with insufficiently high capital reserves and with relatively small capacities for operation according to modern standards. Cooperation with industrial companies and investments in organic agriculture may help it along in its efforts to modernize, in accordance with the general requirements deemed necessary for Serbia alignment with the EU CAP.
- Variability of prices, especially for farmers since they have fewer possibilities to manage risk.
- Uncertainty related to agricultural policy measures which support the production of oil crops in different ways (e.g. premium per kilogram, subsidies for crop production etc.).
- Problems related to “biomass logistics” - the collection, transport, storage, and use of biomass as an energy source in a relatively narrow radius.
- Transportation problems for biomass delivery - bad road infrastructure, bad conditions in railway sector and insufficient use of river transport.

Further sector development is depended to preferential trade agreements with EU countries, CEFTA and other countries. Trade agreement will give the possibilities for strengthen the trade flows and additional utilisation of processing capacities which exist in the country.

5 GRAIN CHAIN

5.1 Profile of the grain chain sector

5.1.1 Production

The cereal grains most frequently grown in Serbia are corn, wheat, rye and barley. The structure of agricultural production in Serbia is such that cereal grain crops are the most important. Of total arable land 63-70 % is annually sown with a combination of these crops. According to the Statistical data for 2017 data, 68 % of the land was under grain crops (Figure 10).

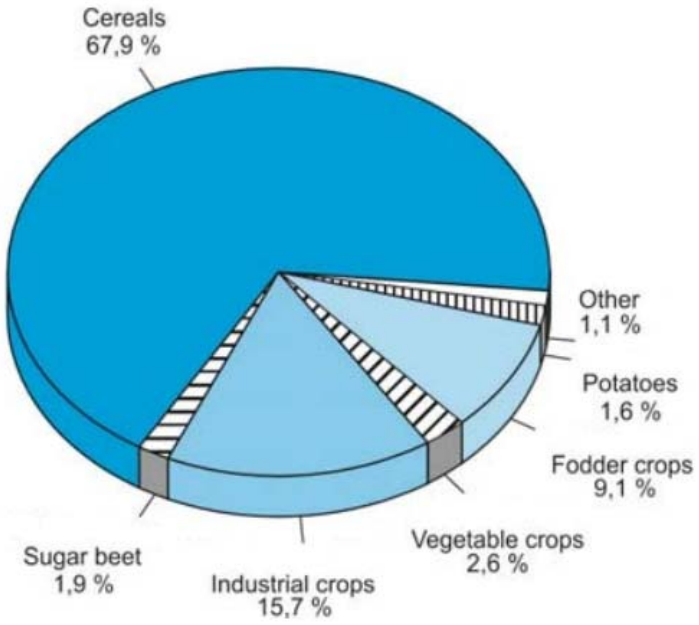

Figure 10. Seeding of agricultural land in Serbia by certain types of crops. Source: Statistical yearbook of the RS, 2017.

Typical use of cereal grain crops in Serbia is for flour production in milling/grinding process. Produced waste from these processes is usually used as a feedstock for the animal feed production. The overall grain chain is presented on the Figure 11. Additional waste which is generated from the field during the harvesting could be used for energy production or for stable flooring.

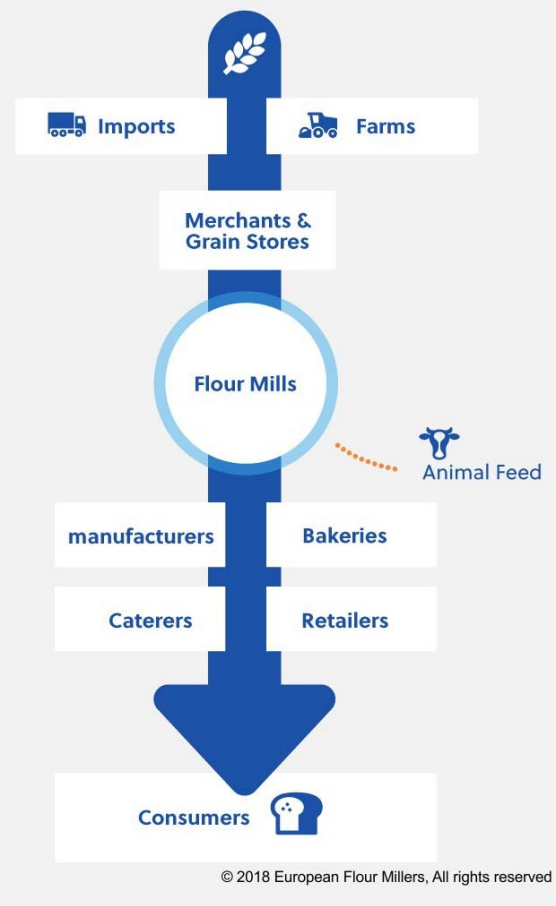

Figure 11. Typical flour production process. Source: http://www.flourmillers.eu//, 2018.

5.1.2 Volume of the sector

Corn (7,376,738 t in 2016) and wheat (595,118 t) dominate the cereal production followed by barley (91,530 t), triticale, oats (27,536 t) and rye (4,891 t). A high share is produced in the north – in Vojvodina. Yields are modest with a high volatility (Tables 13-17).

Corn represents the agricultural crop that is most represented in domestic exports, especially due to the fact that the climatic conditions in the country are especially suitable for corn. During 2011, the export of corn in Serbia was the highest foreign trade income (USD 432 million). Export of corn in Serbia was 551,000 t in 2008, 1,602,073 t in 2009 and 1,626,151 t in 2010 and as it can be seen it has a growing trend – 2,145,679 t in 2016 (USD 383 million).

In Serbia, there are two areas with several districts producing wheat and corn:

- Area of undeveloped districts (South-East Serbia) with the high rank of the land capacities characteristics but with low volume of wheat and corn production,
- Area of relatively developed districts (Vojvodina) with a high level of production volume.

Tables 13 to 19 show the volume of agricultural production in Serbia from 2006-2016 in terms of production of basic types of cereal grains and their utilization.

Table 13. Total production of wheat in Serbia (in thousands of t) in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of wheat in Serbia 2006-2016.			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	607,123	2,367,911	3.9
2007	625,912	2,342,244	3.7
2008	612,256	2,632,091	4.3
2009	636,434	2,598,182	4.1
2010	619,403	2,085,529	3.4
2011	619,612	2,609,188	4.2
2012	603,275	2,399,225	4.0
2013	631,640	2,690,266	4.3
2014	604,748	2,387,202	3.9
2015	589,922	2,428,203	4.1
2016	595,118	2,884,537	4.8

Table 14. Total production of corn in Serbia (in thousands of t) in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of corn in Serbia 2006-2016.			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	962,636	6,016,765	6.3
2007	992,941	3,904,825	3.9
2008	1,048,815	6,158,122	5.9
2009	994,612	6,396,262	6.4
2010	1,014,570	7,207,191	7.1
2011	1,036,859	6,479,564	6.2
2012	976,020	3,532,602	3.6
2013	980,334	5,864,419	6.0
2014	1,057,877	7,951,583	7.5
2015	1,010,227	5,454,841	5.4
2016	1,010,097	7,376,738	7.3

Table 15. Total production of barley in Serbia (in thousands of t) in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of barley in Serbia 2006-2016.			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	98,287	289,652	2.9
2007	98,728	272,489	2.8
2008	97,104	361,617	3.7
2009	100,407	318,491	3.2
2010	89,937	260,998	2.9
2011	81,071	291,613	3.6
2012	80,803	278,367	3.4
2013	90,642	362,205	4
2014	90,803	323,283	3.6
2015	95,984	362,205	3.8
2016	91,530	395,501	4.3

Table 16. Total production of oats in Serbia (in thousands of t) in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of oats in Serbia 2006-2016.			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	49,183	97,628	2
2007	45,844	88,709	1.9
2008	45,881	110,620	2.4
2009	41,254	85,809	2.1
2010	39,747	78,619	2
2011	36,587	82,577	2.3
2012	34,554	77,262	2.2
2013	33,506	88,288	2.6
2014	30,732	74,932	2.4
2015	32,420	88,288	2.7
2016	27,536	81,344	3

Table 17. Total production of rye in Serbia (in thousands of t) in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of rye in Serbia 2006-2016.			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	7,065	15,888	2.2
2007	5,616	11,034	2
2008	5,657	14,442	2.6
2009	5,279	12,943	2.5
2010	5,140	11,061	2.2
2011	5,036	12,791	2.5
2012	4,375	10,640	2.4
2013	4,735	13,258	2.8
2014	5,699	11,702	2.1
2015	5,689	13,258	2.3
2016	4,891	14,200	2.9

Table 18. Wheat utilisation in Serbia 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Wheat utilisation in Serbia 2006-2016.							
Year	Seed use (t)	Feed use (t)	Food use (t)	Closing stocks (t)	Losses (t)	Export (t)	Total consumption (t)
2006	182,000	519,000	1,313,000	410,000	24,000	306,000	2,754,000
2007	188,000	368,000	1,313,000	327,000	23,000	541,000	2,760,000
2008	184,000	537,000	1,250,000	461,000	26,000	511,000	2,969,000
2009	191,000	552,000	1,250,000	401,000	26,000	647,000	3,067,000
2010	186,000	306,000	1,150,000	124,000	21,000	713,000	2,500,000
2011	186,000	565,000	1,160,000	192,000	26,000	614,000	2,743,000
2012	181,000	420,000	1,100,000	29,000	24,000	853,000	2,607,000
2013	190,000	63,000	1,000,000	30,000	27,000	1,427,000	2,737,000
2014	181,000	100,000	1,050,000	244,000	24,000	838,000	2,437,000
2015	177,000	100,000	1,050,000	218,000	24,000	1,124,000	2,693,000
2016	182,000	519,000	1,313,000	410,000	24,000	306,000	2,754,000

Table 19. Corn utilisation in Serbia 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Corn utilisation in Serbia 2006-2016.							
Year	Seed use (t)	Feed use (t)	Food use (t)	Closing stocks (t)	Losses (t)	Export (t)	Total consumption (t)
2006	25,000	4,400,000	140,000	1,669,000	150,000	917,000	7,301,000
2007	26,000	4,250,000	140,000	772,000	98,000	290,000	5,576,000
2008	24,000	4,100,000	200,000	945,000	154,000	1,511,000	6,934,000
2009	25,000	4,100,000	200,000	1,508,000	160,000	1,351,000	7,344,000
2010	25,000	4,050,000	200,000	2,201,000	180,000	2,062,000	8,718,000
2011	26,000	4,100,000	200,000	1,819,000	162,000	2,380,000	8,687,000
2012	26,000	4,000,000	200,000	416,000	88,000	632,000	5,362,000
2013	25,000	3,850,000	200,000	203,000	147,000	1,865,000	6,290,000
2014	25,000	3,900,000	220,000	757,000	199,000	3,061,000	8,162,000
2015	25,000	3,850,000	200,000	366,000	136,000	1,643,000	6,220,000
2016	25,000	3,900,000	220,000	870,000	186,000	2,550,000	7,751,000

As it can be seen from previous Tables, corn is dominant grain in Serbia total production in some years amounted to more than 7 million tonnes (in addition to the quantities of corn, about 600,000 t of animal feed corn are produced annually). Produced quantities of cereal grains in Serbia completely satisfy and exceed domestic food requirements. It is estimated that market surpluses of cereal grains are significantly. For example, domestic demand for corn is estimated at 4-4.5 million t, which means that from the usual annual production, more than 2.5 million t remain (for 2016).

5.1.3 State of the sector

The yields of most crops are relatively low compared to more developed countries and fluctuate significantly. An analysis of the dynamics of yield changes expressed in 10-year averages over the past three decades suggests that cereal yields still do not reach the 10-year average of the pre-transitional period (1980-1989). These data show that further improvement in the sector could be done in future with the intention to increase the yield. Wheat and corn are the two leading products in terms of cultivated areas, with long tradition, good domestic and available foreign assortment. The reason for the insufficient utilization of the genetic potential of plants is the inadequate application of agro-technical measures, the failure to comply with the requirements of the crop and the lower use of inputs related to optimal values and recommendations. High input prices and problems with loan repayments for equipment and machinery have affected the decline in investment volumes, resulting in a high dependence of production on weather conditions according to the Serbian ministry of agricultural.

Average production costs for the main cereal grains in Serbia for period of 2008-2013 are shown in Figure 12. The production costs are influenced by different factors: demand on the market, prices on the world stock markets, fuel prices, fertilizer prices, labour costs, taxes and duties etc. The main reason for decrease of the production prices since 2012 is due to the influence of the world stock

market on national market due to high excesses of these products on international market. It is obviously related to the higher production cost for wheat (approximately 5%) compared to corn.

Serbia has 465 registered mills, 5,755 registered processors and 3 starch factories. Cereals (mainly corn and wheat) cover 17.3 % of all Serbian agricultural exports. More than 80 % of these products are exported to the EU. Serbia applies ad valorem duties of 30 % on imports of cereals for third countries except for rice (3 %). For the EU a preferential regime with no import duties for an unlimited quantity except some products is in place. Preferential access is given also to CEFTA, the Russian Federation, Belarus and Kazakhstan.

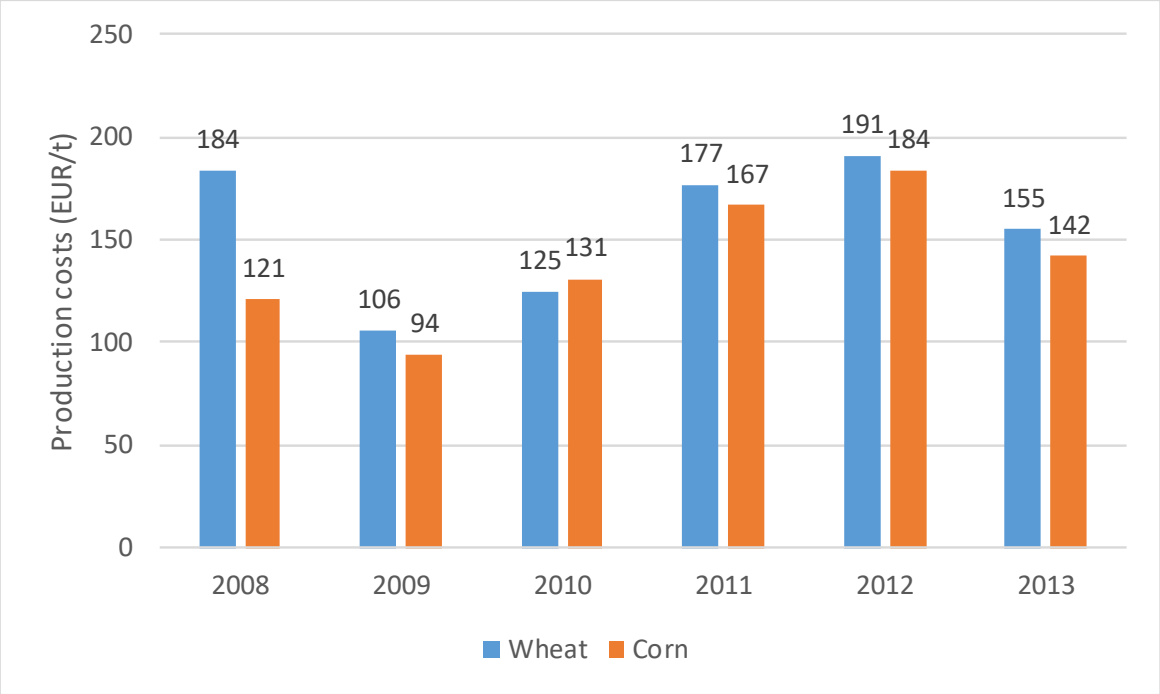

Figure 12. Production costs for wheat and corn from 2008-2013. Source: Official Gazzete RS, 2014.

5.1.4 Typical size of the companies

The company Delta Agrar Ltd. has been present in the agribusiness community since 1993. Its diversified operations are divided into four main organizational segments: primary production, cooperation and repurchase, agro-trade and distribution, and food processing.

Production takes place in five agricultural estates, comprising 15,000 hectares. Crop production includes cultivation of all major field crops: wheat, corn, soybean, sunflower, rapeseed and sugar beet. The export of crop production is up to 40 %. Total number of employees is 1,500.

Danubius Factory from Novi Sad is engaged in the production of milling products and pasta, as well as in storage, drying and transport of grain, all in compliance with strict national and international standards on food safety. Since 2006 Danubius has been operating within Delta Agrar. Total number of employees is 123.

A computer guided mill was installed in Danubius in April 2009 with a daily output of 300 t of wheat processed into various kinds of flours for all purposes. Prior to leaving the mill, all finished products

go through the machines that completely eliminate possible presence of larvae and insects. Danubius has the largest silo in Serbia with a capacity of 65,000 t.

Žitopromet-Ruma was founded in 1950 with headquarters in Ruma. The main activities of the company have always been based on the storage and processing of cereals. The total reconstruction of the mill with new milling technology was done at the beginning of 2014. According to the technological scheme, the capacity of the mill was raised to about 200 t/24hours. A new technology has been introduced for the transport of flour which is pneumatic. All the control process and managing of production is largely automated. In addition to wheat flour in basic types and packages, five types of pasta in three basic categories (short, long and dipped pasta) are produced, so the assortment of final products is increased in comparison with the previous years. Total number of employees is 80.

In addition to trading activities as basic activities, three companies are engaged in cereal processing as well: Granexport, Žitobačka and Maxiprotein. Granexport, based in Pančevo, in addition to the organization of agricultural production and a significant share in the trade activities of the division, as well as the fact that due to its geo-strategic position (the Danube bank, industrial railroad track) represents the main point of the logistics chain with the possibility of loading goods directly to the vessels; with a silo of 50,000 t and a mill (capacity 140 t per day) - also performs final finishing of corn grain. Products intended for the consumer market and industrial consumers are: corn flour, corn semolina and polenta in packages customized to the requirements of the customer. Total number of employees is 101.

Žito-Bačka, with headquarters in Kula, in addition to the organization of agricultural production and trade in cereals - also performs processing of wheat grain, producing more types of flour in packages tailored to the requirements of the end customer (bulk packages, large packages of 25 and 50 kg, small packages intended for sale through a retail chain of distribution).

Žito Bačka's mill was founded in 1916. After a thorough reconstruction in 1975 it began to work as one of the largest and most modern facilities of that time. After privatization in 2004 the company expanded its core business and ensured its leading position in Serbia and the region. The daily flour production is 220 t. It also has a storage capacity for 3,000 t of bulk flour. The mill was reconstructed in 2013, which increased the product range The high-tech laboratory performs daily analyses and takes care of the quality of the flour. With storage capacities of 155,000 t, Žito-Bačka is one of the largest warehouses in Serbia. Silos in Kula have a capacity of 50,000 t. Of the stated capacity 30,000 t is used for the storage of all agrarian crops, including cereals and oilseeds, while 20,000 t are used exclusively for the storage of wheat.

It should be emphasized that the storage and service capacities of Žito-Bačka in Kula are now tripled compared to the previous period (before 2013), since storage is carried out within the silos in Kula with a capacity of 50,000 t, Silos PJ in Bačka Topola with a capacity of 65,000 t and Silos PJ in Belgrade capacity 40,000 t. Total number of employees is 65.

Mirotin Group is a group of companies engaged in the production and marketing of agricultural products, as well as raw materials for primary production and food industry. The company was founded in 1992. The operations of Mirotin Group are largely focused on the foreign markets. Over 70 % of the company's foreign trade operations stem from the export of products, primarily to the

markets of the former Yugoslavian republics (Slovenia, Croatia, Macedonia, Bosnia and Herzegovina, Kosovo, Montenegro), as well as to the markets of the EU Member States: Italy, Germany and others. The main companies within Mirotin Group are Sava Kovačević AD and Mirotin Tisa. Total number of employees is 267.

The main products of company Sava Kovačević AD are following:

Agriculture and vegetables: wheat, barley, corn, sunflower, soybean, sugar beet

Seed production: processing of wheat seeds, corn processing

Corn mill Savino Selo operates within the company Mirotin Tisa. The processing capacity of the mill is 240 t of corn grain in 24 hours. The following products are in the mill's production program:

- edible corn flour
- enriched animal feed corn flour
- beer pie (beer semolina)
- corn semolina for human consumption
- corn semolina for pharmaceutical use

5.1.5 Distinctive facilities of the sector

The overview of grain chain sector has shown that the annual use of wheat for food use in Serbia is 1.2 million t. About 860,000 t of flour is produced which is used for the production of bread and pastry, direct consumption of population, pasta, confectionery and export. Analyses therefore show that Serbia needs an annual amount of 377,000 t of flour and 51,000 t of baked goods. For pasta 42,000 t of flour is consumed, while 54,000 t of flour annually is required for the work of the confectionery industry. In 2016 the export of about 200,000 t of flour was reached. So Serbia needs about 780,000 t of flour annually for normal functioning. Therefore, there is room in the balance of flour to increase its exports.

According to the available data about the companies in this sector, the limited information about the biomass residues are presented. In the last ten years, the companies made a lot of efforts in increasing the grain yield and export. Additional attempts related to biomass residues utilization have been sporadic. Utilization of biomass residues in future will need the investment in the equipment and that could be interesting also for the examination of the possibilities for IBLC. Additionally, the companies underline the need for further development of the infrastructure – collection, transport (road, rail and river) and storage capacities.

5.1.6 Degree of innovation

According to the available data about the companies in this sector, the limited information about the biomass residues are presented. In the last ten years, the companies made a lot of efforts in increasing the grain yield and export. Additional attempts related to biomass residues utilization were/have been sporadic. Biomass utilization residues in future will need the investment in the equipment that could be interesting related to the IBLC implementation. Additionally, the companies underline the need for further development of the infrastructure –collection, transport (road, rail and river) and storage capacities.

The grain sector is considered very suitable for IBLCs and some experience is available from previous period. As big companies are involved in cereals production, they started with different organizational activities (organizing the individual farmers for cooperation), collection of residue from production and utilization of the residue for different purpose.

5.1.7 Miscellaneous

The primary production in the grain chain sector is mainly sustainable with taking care related to crop rotation and soil protection. The main problem is leaving the biomass on field and very often burning of biomass residues in the fields. The problem for insufficient collection and utilization of biomass residue is related to the lack of regulation and inspection, especially in environmental sector which is responsible for prevention of uncontrolled biomass combustion on the field. Additional problem is due to the complete uncompetitive price of different energy sources comparing to biomass energy generation and lack of economic reasons for biomass residues utilization.

5.2 Opportunities IBLC

5.2.1 Sector related residues

The basic production of cereal grains generates the same or higher quantity of plant residues. In some regions, secondary raw materials have taken up their functional position in the continuation of the production process, and somewhere they represent the ballast. Due to this reason, several attempts for estimation of residues from cereal grains production were made. Detailed analysis was done and presented in literature [Ilic et al., 2003]. The total quantity of residues in the field is 8.5 million t, with the share of enterprises and cooperatives of approximately 17 %, and 83 % of the individual producers. The amount of residues that can be expected to be used in energy sector is 2.7 million t, with the share of enterprises and cooperatives of 33 % and 67 % by the individual sector. Additionally, the residue of the most important dominant cereal crops – wheat and corn are estimated for each region (25 of NUTS3). Due to the big differences in harvested area, total yield and yield per unit, the range of residue production per unit is also wide (Table 20).

Table 20. Residues per unit. Source: Statistical Office of the Republic of Serbia, 2017.

Residues per unit		
Type of residue	Residue per unit (kg/ha)	
	Range	Average value
Wheat	2,544-4,847	3,546
Corn stalks	5,033-38,483	17,616

These residues are very interesting for further utilization, as they can be used for different purposes – pellet production, direct combustion of straw bales, utilization for next generation biofuel production, gasification etc. According to National action plan for renewable energy sources in the Republic of Serbia, biomass from grain chain will have an important role contributing to target fulfilment in 2020. According to NREAP targets for different sectors, it could be concluded that

biomass residues will be available for utilization in CHP plants (based on 2009, the additional 19 ktoe in electricity and 10 ktoe in heating sector is planned) and 246 ktoe for transport sector, mainly based on biofuels (preferably 2nd generation). All estimated biomass residues from grain chain sector are suitable for partially utilization in previously mentioned sectors.

5.2.2 Potential synergies & benefits

The grain production sector has the potential to be linked with other sectors and it could so be used for establishment of IBLCs. This is especially interesting as there are unused and larger than needed capacities and the biomass residues, most feasible straw and corn stalk, which are not used. It is necessary to emphasise that two types of companies exist: companies with big capacities (mainly located in Vojvodina) and small companies (in the rest of territory).

Big companies cover great areas and have sophisticated equipment for IBLCs (mainly, for collection, loading and transport). They have the capacities for relatively low cost transport and appropriate storage. Big companies have made a lot of efforts for optimal use of natural resources, strategic planning and application of modern agro-technical measures. They have optimized all costs through control and monitor all operations, trained and efficient labour, automated and modern agricultural mechanization, advanced logistics and strong information support and large and easily accessible storage capacities. One good example is company MK Commerce which is leader in the field of agribusiness. On the domestic market, they are one of the biggest producer in agriculture sector overall, as well as one of the largest producers of agricultural crops, such as sugar beet, wheat and corn.

On the other side, the small producers are faced with several problems: relatively small areas to collect biomass from, lack of equipment, relatively poor road infrastructure and relatively small capacities of warehouses. Due to all these reasons implementation of IBLCs will have higher costs but it could be expected that based on good practice, relatively small companies and private owners will start with implementation of IBLC. Different examples in organization of small producers exist and it could be expected that their good practice will be enlarged. These examples are: associations, clusters and cooperation with big companies based on long term agreement for cooperation. Based on the experience, all these examples have shown the advantages in equipment share, knowledge upgrading, and implementation of new technologies, management and logistics. Additionally, structural shifts whereby large family farms are buying and renting land from elderly households and the government is improving the growing technology. Therefore, yields are increasing as more land is cultivated by professional producers who are better informed about new technologies and modern production equipment.

5.2.3 Market developments

Grain chain industry is the industry with a big tradition in Serbia and with constant development, especially in yield. The companies involved in grain chain sector made in 1978 Association Serbia Grains (previous name Yugoslavian Grains Association). The association includes 46 member companies which organize production on 980.000 ha. Association members share in total grains export from Serbia in period 2007-2017: corn from 68 to 86 % and wheat from 62 to 83 %. According to the Law on agriculture and rural development from 2009, Serbia is exclusively producing NON-

GMO grains. The Danube waterway in Serbia is the main path for grains export, with total storage capacity for grains on Danube in Serbia – 224,000 t.

5.2.4 Non-technical barriers

The main problem is related to economic aspects. The price of fossil fuel is relatively low compared to biomass. Additionally, implementation of IBLCs is linked with additional financial investments and relatively long period for the return on investments.

Another reason for the insufficient utilization of the genetic potential of plants is the inadequate application of agro-technical measures, the failure to comply with the requirements of the crop and the lower use of inputs in relation to optimal values and recommendations. High input prices and problems with loan repayments for equipment and machinery have affected the decline in investment volumes, resulting in a high dependence of production on weather conditions.

6 FEED AND FODDER

6.1 Profile of the feed and fodder sector

6.1.1 Production

Since livestock production occupies an important place in agricultural production in Serbia, the feed and fodder sector is relevant in the country rural economy. Dominant fodder crops which cultivated for use in this sector for feed are maize for forage, clover and alfalfa (lucerne). The traditional production process (Figure 13) used in the processing plant for the animal feed production can be divided into phases, namely:

- Receiving and storing raw materials (which can be received and stored in silos, bags in floor warehouses and "big bags")
- Milling preparation
- Dosing raw materials
- Milling/Grinding
- Mixing
- Packing mixtures of finished products in bulking cells
- Shipping by trucks

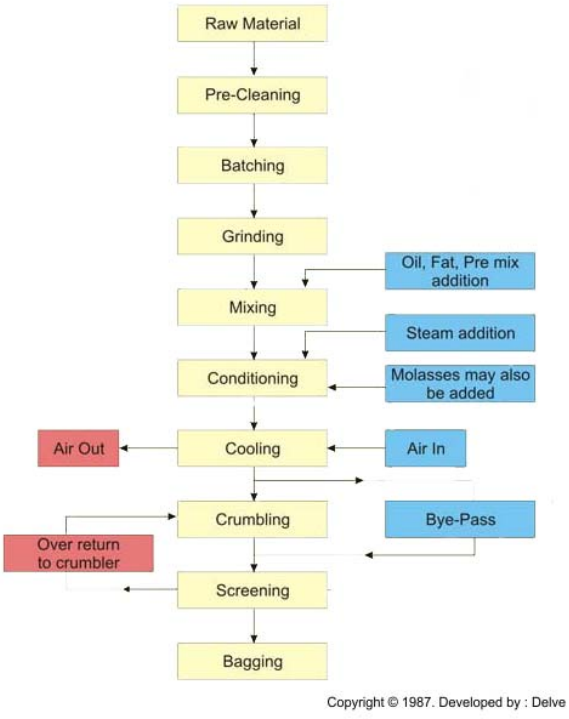

Figure 13. Traditional production process of animal feed. Source: http://spectecindia.com/, 2018.

The commonly used end product of this sector are mixtures for pigs, cattle and poultry that are used in domestic livestock production.

6.1.2 Volume of the sector

There are approximately 100 producers of animal feed in Republic of Serbia and the most important are listed in Table 16. The majority of the producers are with small production potentials and they have been operating only for couple of years. However, regarding the amount of the fodder crops production which is presented in Tables 21, 22 and 23, all installed production capacities for animal feed could be used. Market trends and price fluctuations affect the viability of the animal feed production. For small producers with relatively low storage and production capacities it is most difficult to survive in this market.

Table 21. Total production of maize for animal feed in Serbia in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of maize for animal feed in Serbia 2006-2016			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	23,285	502,092	21.6
2007	26,302	460,329	17.5
2008	25,318	459,310	18.1
2009	26,758	586,919	21.9
2010	27,503	657,201	22.9
2011	30,157	655,618	21.1
2012	47,927	736,943	14.9
2013	32,418	693,258	20.7
2014	32,143	617,447	19.2
2015	34,046	589,166	17.3
2016	30,524	650,741	21.3

Table 22. Total production of clover in Serbia in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of clover for animal feed in Serbia 2006-2016			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	108,199	635,778	5.9
2007	107,210	520,825	4.9
2008	110,290	609,462	5.5
2009	108,168	634,078	5.9
2010	107,665	628,438	5.8
2011	105,458	561,034	5.3
2012	103,316	416,571	4.0
2013	101,604	504,259	5.0
2014	108,834	565,886	5.2
2015	109,230	481,003	4.4
2016	107,430	611,062	5.7

Table 23. Total production of alfalfa (lucerne) in Serbia in the period 2006-2016. Source: Statistical Office of the Republic of Serbia, 2017.

Total production of alfalfa (lucerne) for animal feed in Serbia 2006-2016			
Year	Production area (ha)	Production (t)	Yield (t/ha)
2006	79,201	358,937	4.5
2007	78,057	285,921	3.7
2008	78,097	331,366	4.2
2009	76,436	344,495	4.5
2010	77,734	352,601	4.5
2011	78,304	314,780	4.0
2012	77,726	245,847	3.2
2013	75,102	282,234	3.8
2014	75,395	244,658	3.2
2015	76,625	222,596	2.9
2016	73,281	291,365	4.0

6.1.3 State of the sector

Production facilities in the feed and fodder sector of Serbia are relatively well distributed in the country regions. Although Vojvodina and Belgrade region are declared with the largest number of manufacturers for animal feed production. This is because of higher population density in that regions and higher raw materials and fodder crops availability. The main companies which deal with production of animal feed in Serbia are shown in Table 24.

Table 24. The main producers of animal feed in Serbia. Source: UBFME, 2018

The main producers of animal feed in Serbia			
Company name	Location	Company name	Location
FSH Sto	Belgrade	AGROPRODUKT d.o.o.	Kragujevac
DOO "Gebi"	Čantavir	TONNEJA	Kraljevo
AGRO MIL	Pojate	PP "POMAK"	Kraljevo
FSH"DE HEUS" d.o.o	Šabac	STR "AGROPLUS"	Kragujevac
HRANA PRODUKT	Sremska Mitrovica	DOO BRANA "MM-KOMERC"	Varvarin
VETERINARSKI ZAVOD "SUBOTICA"	Subotica	NUSCIENCE PREMIX INTERNATIONAL	Velika Plana
PANTELIĆ d.o.o	Kraljevo	FSH INTERFOOD	Valjevo
FSH JABUKA	Pančevo	DOO DREN	Novi Sad
Konzul- PJ FSH "BAFI"	Novi Sad	FARMER d.o.o	Čačak
FSH Nutriko	Vranje	"MELBAT" ŠAJKAŠKA	Novi Sad
DEM KUPLIN	Kulpin	INBERG	Boljevci
AGROSMEŠA	Surčin, Belgarde	DOLINA GRUŽE	Kraljevo

The Republic of Serbia has favourable natural conditions for the development of animal husbandry, since it possesses grasslands of high quality and with significant unused facilities for accommodation of cattle and sheep. Nevertheless, this branch of agriculture has been recording negative trends for the third decade now. Only during the last ten years, the number of livestock and poultry per hectare of agricultural land was reduced from 0.34 to 0.27 (Table 25).

Table 25. Number of livestock and poultry in Serbia. Source: Statistical Office of the Republic of Serbia, 2017.

Number of livestock and poultry in Serbia 2006-2016.				
Year	Cattle	Pigs	Sheep	Poultry
2006	1,098,000	3,759,000	1,527,000	17,596,000
2007	1,106,000	3,999,000	1,556,000	16,595,000
2008	1,087,000	3,832,000	1,606,000	16,422,000
2009	1,057,000	3,594,000	1,605,000	17,188,000
2010	1,002,000	3,631,000	1,504,000	22,821,000
2011	938,000	3,489,000	1,475,000	20,156,000
2012	937,000	3,287,000	1,460,000	19,103,000
2013	921,000	3,139,000	1,635,000	18,234,000
2014	913,000	3,144,000	1,616,000	17,860,000
2015	920,000	3,236,000	1,748,000	17,167,000
2016	916,000	3,284,000	1,789,000	17,450,000

6.1.4 Typical size of the companies

According to Agricultural census 2012, In Serbia there are around 100 companies producing animal feed without classification by size. Also, in the available materials (literature, company presentation etc.) there is limited information about production capacities and other information related to their business results.

6.1.5 Distinctive facilities of the sector

There are no possibilities for other biobased purposes in the existing capacities. All existing capacities are oriented only for feed and fodder production and there are no idle periods in which could be equipment used for biomass processing. This is especially due to the large number of small producers with small capacities and limited financial capabilities.

6.1.6 Degree of innovation

The entire technological process of animal feed production in all factories is automated: by introducing computer technology, precise control and management of the production process has been achieved, and every possibility of error has practically been eliminated. In some of the production process the technologists, with the help of the most modern program for the optimization of mixtures and the latest knowledge in the field of nutrition of domestic animals, creates mixtures that meet the most stringent requirements of customers and prescribed standards. Some companies have established close cooperation with many faculties, mainly department for livestock breeding whose experts regularly monitor and control the quality of the products.

For the purpose of efficiency of production, the factories have modernized their production in order to meet the needs of their customers by investing in machinery and equipment, as well as by building a larger production and warehouse space. For example, company "NUTRIKO" has its own laboratory, equipped with state-of-the-art equipment for quality control of raw materials and finished products.

6.1.7 Miscellaneous

There are no possibilities for future IBLC development due to significant annual fluctuations in price and quality caused by large annual variations in yields and areas in crop production and non-competitive markets (production, import and sale).

6.2 Opportunities IBLC

6.2.1 Sector related residues

Regarding feed and fodder sector related residues which could be used in IBLCs are not available in significant quantities due to old and traditional animal feed production process as well as relatively large number of small producers. Therefore, the amount of residues that could be collected in each small producers facility is quite reduced and will not be worth to implement a system to valorise them. Additionally, the alternative to gather the residues from different facilities close to each other would not be suitable due to the relatively long distance between the facilities and the poor

interconnection infrastructure. Also traditional livestock breeding which is dominant in Serbia, use relatively small quantity of the biomass residues from this sector as additional food for livestock and for flooring of the stables and the cotes. After the changes of biomass used for flooring, this waste material is used as a natural fertilizer for fields and crops in rural areas of Serbia.

6.2.2 Potential synergies & benefits

As mentioned above due to no available residues from feed and fodder sector in Serbia there are no potential synergies and benefits which could be obtained. According to Agricultural strategy it could be expected that in the future period the livestock sector will be in expansion and as a consequence feed and fodder production will increase, which enable some potential synergies and benefits. At the same time, it could be expected that in that case larger companies will appear on the market which will be more interested for implementation of IBLCs.

6.2.3 Market developments

The business plans of companies from this sector have shown the intention for increase the production and export to other markets. For further market development different incentives have been recognized and planed for implementation in the future:

- Incentives for machinery purchasing for the preparation and distribution of animal feed.
- Support through different financial mechanism of construction of fodder storage facilities.

6.2.4 Non-technical barriers

According to the national program of agriculture sector in the Republic of Serbia, different non-technical barriers are recognized:

- Lack of law on fodder food.
- Lack of regulation which define storage, declarations, controls and other issues related to the production and marketing of concentrated animal feed.
- A large number of small manufacturers that do not meet standards and have no homogeneity regarding the quality.
- Lack of procedure to define the custom clearance.

Additionally, as the main non-technical barrier which has the influence on the amount of production is dependence to weather conditions. Dependence on weather conditions is especially pointed out by small producers which are not capable to implement modern technologies and measures in production process due to the lack of knowledge or insufficient investment capacity.

7 SUMMARY ANALYSIS OF THE COUNTRY

Table 26. Summary sector "Sugar Industry".

Sugar Industry	
	Profile
Production	• Sugar is produced from sugar beet. • A tonne of sugar beet yields on average 14-16 % of its mass in sugar. • Main by-products: dried shredded sugar beet, pelleted pulp and high-quality molasses.
Volume of the sector	• In 2016 total production of sugar beet was 2,683,860 t, sown area 49,237 ha. • In 2016 total production of white sugar was 626,000 t. • annual production of sugar beet is in the range from 2,200,000 to about 3,300,000 t in the period from 2006 to 2016. • Between 1 and 1.5 % of the total available land is used for sugar beet cultivation. • 400 farms are involved in the process of beet production.
State of the sector	• Each factory carries out its own contracting directly with the farmers who supply beets. • Approximately 180,000 to 200,000 t of white sugar are exported. • The equipment in the sugar plants is modern, especially in larger plants. • The domestic sugar consumption is stable – 240,000 t, 25-30 kg per capita.
Typical size of the companies	• The sector is dominated by medium and large producers. • 7 sugar plants are operated. • All facilities for sugar production are located mainly in the north part of Serbia (Vojvodina). • Total capacity of facilities for sugar production is 4.4 million tonnes of sugar per year. • Facilities for sugar production are active on average for 100 days per year.
Distinctive facilities of the sector	• Some of the biggest producers are Sunoko (4 facilities) and Helenic Sugar (3 facilities). • Characteristic for all plants is the equal number of permanent employees and seasonal workers. • Huge difference in the fuel cost between the factories that burn coal and those that use gas. • As all sugar plants remain idle for the bigger part of the year it will be reasonable to examine the possibilities for IBLC.
Degree of innovation	• In the last few years many efforts and improvements were made to increase energy efficiency.

Miscellaneous	• It could be expected that due to the environmental legislation the factories will evaluate the switch to fuel with less environmental impact.
	• There is a significant potential for biomass utilization in the sector. • Comparable economic and environmental assessment using Life Cycle Assessment method was carried out for raw sugar juice production.
	Opportunities for IBLCs
Sector related residues	• Dried shredded sugar beet, pelleted pulp and high-quality molasses are the main by-products. • In some plants the use of 80 % of the sugar from molasses that occurs after sugar beet processing
Potential synergies & benefits	• There is the opportunity for bioethanol production. The molasses as a by-product of sugar production is identified as raw material for bioethanol production. • The utilization of sugar production residues (dried shredded sugar beet) could be also very interesting, as it will improve environmental situation due to reduction of call utilization as main fuel in sugar industry.
Market developments	• The trend for increasing sugar production and possibilities for export in the region is realistic.
Non-technical barriers	• As three sugar producers operate in the market certainly the issue of monopolies is opened. • The abolition of the sugar production quota in the European Union will also affect sugar beet producers. • The unresolved relationship and the poor leasing of state land.

Table 27. Summary sector "Wine".

Wine sector	
	Profile
Production	• There are nine main wine regions. • Grape and wine production is increase in last two decades. • The last decades after 2000. was characterized with introduction of new technologies in grape growing and wine production by use of quality, selected and certified grape variety materials. • Residues such as pruning are very rare used as biomass. • Vojvodina is the first region in Serbia which becomes a member of the Association of Wine Regions of Europe.
Volume of the sector	• 80,341 farms are engaged in the production of grapes, which is 12.7 % of the total number of farms.

	• Four types of vineyards: 1) small family vineyards (0.1-0.3 ha); 2) small to medium-sized vineyards that belong to grape growers focused on production for the commercial wineries; 3) modern small-medium vineyards that belong to the wine-makers (integrated firms); 4) largely older large vineyards (up to 1,400 ha) • The number of employees in wineries in Serbia is 3,415, out of which the number of permanent employees is 1,956, and temporary employed persons are 1,459.
State of the sector	• 235 wine producers who are exclusively market oriented • Serbia has recorded a growth of wine production at an average annual rate of 8.63 %.
Typical size of the companies	• Large winery with more than 250 employees - only two wineries, and in a group of wineries with 50 to 250 employees is an only one winery. • 3 types of wineries - Industrial/corporate producers (wine and cognac production), medium-sized wineries that produce wines in the high-end and premium segments (around 500,000 litres per year), small wineries (10,000 to 80,000 litres per year).
Distinctive facilities of the sector	• IBLC could be the part of modernization process of industrial / corporate producers, as they started with some activities in planning and realization of modernization.
Degree of innovation	• Significant progress in improving technologies for viticulture and oenology and in improving wine quality and production. • Subsidies given for viticulture and oenology are among the largest subsidies in the region.
Miscellaneous	• The main limiting factors for grape production in Serbia are very old plants (older than 30 years), which should be renewed and for this a significant investment is needed. • Small plots prevent the use of productive machines and performing the necessary agro technical measures.
	Opportunities for IBLCs
Sector related residues	• According to the investigation related to biomass potential in Serbia, the pruning of vine yields is from 4 up to 8 t/ha of vineyard. • Total biomass residues from grape growing could be estimated at about 170,000 t, which is the energy potential of about 50,000 toe. The energy potential of vine pruning residues alone is about 55,000 toe.
Potential synergies & benefits	• Idle period of wine cellars usually is from January until August. • The interest for IBLC in wine sector exists. • The main reasons for relatively low biomass utilisation lie in lack of adequate equipment for biomass collection and relatively small vineyards area.

	• There are some idea and attempts for biomass collection and joint procurement of the necessary equipment by several small producers.
Market developments	• Wine sector has a lot of opportunities for further development: there are lot of potential for improved quality, lower price on the domestic market and bigger export to other markets. • Improving knowledge in viticulture and wine production, including possibilities for energy efficiency and biomass utilization is one of the activities identified as the most important for upcoming period.
Non-technical barriers	• Equipment is outdated and there are no resources to upgrade equipment and to improve winery operation and its efficiency. • The most essential changes required in the Serbian wine value chain is the expanded use of long term contracts for wine grape supply and biomass which could be used.

Table 28. Summary sector "Vegetable Oil Extraction".

Vegetable Oil Extraction sector	
	Profile
Production	• The most important plants that are cultivated in Serbia for vegetable oil extraction process are rapeseed, sunflower and soybean. • The vegetable production is in Vojvodina. • Main residues form the process are husk and oilcake.
Volume of the sector	• In 2016 total production of vegetable oil was more than 1.2 million t. • Over 150,000 ha are sowed with sunflower, equalling about 5 % of arable land. The major part of this areal (94 %) is in Vojvodina. • The average area in Serbia sown for soybean production is 160,000-180,000 ha, with the tendency of constant growth.
State of the sector	• Average yields of sunflower have been going up and down in the recent years. For soybean and rapeseed – steadily increasing is recorded. Since 2015 there has been a significant (around 20 %) in production volumes of sunflower. Due to high profitability of this crop.
Typical size of the companies	• The companies play as an important factor in the agricultural sector, particularly in the production of oilseeds, which includes the development of partnership relations with agricultural producers, as well as the development of logistics coverage for the purpose of purchase and a modern, safe storage of the oil crops. • By engaging agricultural engineers, a number of agricultural producers have been trained educated, which is one of the most important requirements for accepting this culture.

Distinctive facilities of the sector	• Total capacity of vegetable oil industry is higher than needed. • Oil production industry has made significant investments in modernization. • Developed logistics network. • A lot of possibilities for IBLC. • Vegetable oil industry in Serbia has a lot of experience with sunflower husk utilisation.
Degree of innovation	• Compared to other sectors analysed in this report, the vegetable oil sector may be considered the most innovative. • Investments were done with the intention to improve the factory's performance. • Successful co-operation with farmers.
Miscellaneous	• In Victoria Logistic which has the cooperation with around 40,000 farmers through more than 300 co-operatives, the purchase of different biomass (soy straw, wheat and corn) is organized, as well as the production and sale of biomass pellets.
	Opportunities for IBLCs
Sector related residues	• Residues from the vegetable oil extraction sector, like sunflower husk or residues from oil extraction process (oil waste), are mainly used within facilities for production energy for own use.
Potential synergies & benefits	• Intention for integration production of biofuels, especially of next generation biofuels due to the surplus in processing capabilities. • Big a surplus offers an opportunity for an IBLC.
Market developments	• The market of vegetable oil will grow in future. • Plans and strategies for further investment in energy efficiency and biomass are made.
Non-technical barriers	• Small farm with insufficiently high capital reserves and with relatively small capacities for operation according to modern standards. • Variability of prices, especially for farmers since they have fewer possibilities to manage risk. • Uncertainty related to agricultural policy measures which support the production of oil crops. • Transportation problems for biomass delivery - bad road infrastructure, bad conditions in railway sector and insufficient use of river transport.

Table 29. Summary sector "Grain Chain".

Grain Chain sector	
	Profile
Production	• The cereal grains most frequently grown in Serbia are corn, wheat, rye and barley. • Cereal grain crops are the most important: by 63-70 % of arable land is sowed annually with a combination of these crops.
Volume of the sector	• In 2016 total production of grain crops was around 11.5 million t. • Main grain crops produced in Serbia are wheat and corn. • Two groups of districts with wheat and straw production: undeveloped districts (South-East Serbia) with low volume of wheat and corn production and group of relatively developed districts (Vojvodina) achieving a high level of production volume.
State of the sector	• The yields of most crops are relatively low compared to more developed countries and fluctuate significantly. • Cereals (mainly corn and wheat) cover 17.3 % of all Serbian agricultural exports. • More than 80 % of these products are exported to the EU.
Typical size of the companies	• The main part of production is in medium and big companies. • Some of companies is organized for different operations: primary production, cooperation and repurchase, agro-trade and distribution, and food processing. • Due to geo-strategic position (the Danube bank, industrial railroad track) some of companies represents the main point of the logistics chain with the possibility of loading goods directly to the vessels.
Distinctive facilities of the sector	• Serbia needs about 780,000 t of flour annually for normal functioning. • In 2016, the export of about 200,000 t of flour was reached.
Degree of innovation	• The degree of innovation in the grain chain sector is rather low, which results in substantial amounts of residues generated during primary production, as well as during industrial processing gone unused (or used inefficiently).
Miscellaneous	• The primary production in the grain chain sector is mainly sustainable with taking care related to crop rotation and soil protection. • The main problem is often burning of biomass residues in the fields.
	Opportunities for IBLCs
Sector related residues	• The total quantity of residues in the field is 8.5 million t, with the participation of enterprises and cooperatives about 17 %, and the individual sector 83 %.

	• The amount of residues that can be expected to be used in energy sector is 2.7 million t, with the participation of enterprises and cooperatives from 33 % and the individual sector from 67 %. • Residues are very interesting for further utilization (pellet production, direct combustion of straw bale, utilization for next generation biofuel production, gasification etc.).
Potential synergies & benefits	• The sector of grain production has the potential to be linked with other sectors and it could be used for establishment of IBLC. • Big companies cover great areas and have sophisticated equipment for IBLC.
Market developments	• Grain chain industry is the industry with big tradition in Serbia and with constant development.
Non-technical barriers	• Economic aspects - the price of fossil fuel is relatively low compared to biomass. • High input prices and problems with loan repayments for equipment and machinery. • Inadequate application of agro-technical measures.

Table 30. Summary sector "Feed and Fodder".

Feed and Fodder sector	
	Profile
Production	• Since livestock production occupies an important place in agricultural production in Serbia the feed and fodder sector is important in the country's rural economy. • Dominant fodder crops which cultivated for use in this sector feed are maize for forage, clover and alfalfa (lucerne).
Volume of the sector	• There are approximately 100 producers of animal feed in Republic of Serbia • Regarding to amount of the fodder crops production, all installed production capacities for animal feed could be used. • Market trends and price fluctuations affect the viability of the animal feed production.
State of the sector	• Production facilities in the feed and fodder sector of Serbia are relatively well distributed in the country regions. • Serbia has favourable natural conditions for the development of animal husbandry, since it possesses high quality grasslands and significant unused facilities for accommodation of cattle and sheep. Nevertheless, this branch of agriculture has been recording for the third decade negative trends. Only during the last ten years, the number of livestock and poultry agricultural land it was reduced from 0.34 to 0.27.

Typical size of the companies	• Limited data related to company size.
Distinctive facilities of the sector	• All existing capacities are oriented only for feed and fodder production.
Degree of innovation	• The entire technological process of animal feed production in all factories is automated. • For the purpose of efficiency of production, the factories have modernized its production in order to meet the needs of its customers by investing in machinery and equipment, as well as by building a larger production and warehouse space.
Miscellaneous	• There are no possibilities for future IBLC development.
	Opportunities for IBLCs
Sector related residues	• Sector generates no biomass related residues.
Potential synergies & benefits	• No available residues from feed and fodder sector in Serbia there are no potential synergies and benefits which could be obtained.
Market developments	• The business plans of companies from this sector have shown the intention for increase the production and export to other markets.
Non-technical barriers	• Dependence of production/yield to weather conditions.

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