The feasibility of direct processing of sugar beets in Slovenia: a quick scan

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In deze quick scan is de economische haalbaarheid onderzocht van directe verwerking van suikerbieten voor de productie van ethanol in Slovenië, gebruikmakend van het zogenaamde Betaprocess. Bij de na de liberalisering van het EU-suikerbeleid in 2017 verwachte prijzen voor suiker, suikerbieten, ethanol en andere relevante akkerbouwproducten blijkt de teelt van suikerbieten voor directe verwerking tot ethanol economisch rendabel te zijn, mits aan bepaalde voorwaarden wordt voldaan.

Trefwoorden: suikerbiet, akkerbouw, biobrandstof, Slovenië

This study presents a quick scan of the economic feasibility of direct processing of sugar beets for ethanol production in Slovenia, using the Betaprocess technology. The outcome is that given the prices for sugar, sugar beets, ethanol and other relevant arable crops that are expected to prevail after the liberalisation of the EU's sugar policy in 2017, direct processing of sugar beets is a profitable activity. This result is conditional on a number of requirements.

Key words: sugar beet, direct processing, ethanol, biofuel, Slovenia

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Preface

The Dutch Ministry of Economic Affairs has asked LEI Wageningen UR to make a quick scan of the economic feasibility of direct sugar beet processing, with an application to Slovenia.

The study has been carried out by Roel Jongeneel, Bert Smit and Jakob Jager from LEI, and Tom Bakker, an independent consultant.

The study has been reviewed by Dr. Gerdien Meijerink, unit head International Policy of LEI and professor Crtomir Rozman from the University of Maribor, Slovenia. The reviewers are thanked for their valuable comments. Special thanks go to professor Rozman for his efforts in revising this Wageningen UR report.

Prof. Dr. Ir. J. G.A.J. van der Vorst
General Director Social Sciences Group - Wageningen UR

Summary

Dismantling of the EU's sugar policy is expected to lead to an EU sugar price decline. The EU ethanol price is expected to show a modest increase and ethanol production will become more attractive relative to sugar production
Up to now the sugar sector has been strongly regulated, with a policy arrangement that affects the price structure in the EU's internal market. However, it has been announced that as of October 2017 this sugar policy is to be dismantled.

As a result of the CAP's sugar policy reform, it is expected that the EU sugar price will decline by about 25%, whereas the price of ethanol is expected to rise by about 15%. The ethanol price is strongly policy driven. For the cereal prices, a modest price decline is foreseen.
The increased market orientation of the CAP implies that EU prices will more closely follow world market prices and are also likely to be more volatile than in the past. Also the link with energy markets (via the demand for biofuels) has become stronger.

Cultivating sugar beets for ethanol production using the Beta-process direct processing technology provides a profitable business
Scenario analysis shows that, taking into account future expected market conditions, cultivating sugar beets for ethanol production using the Beta-process direct processing technology provides a profitable business case, given that some side conditions are satisfied. The business case has a commercially acceptable positive return on investment when paying a market price for sugar beets that varies between €30 to €35 per tonne.

Direct processing contributes in two ways to the income position of sugar beet growers, i.e. (1) as a sugar beet producer and deliverer of the beets to the factory, and (2) as a shareholder of the factory receiving dividend from the farmer organisation (as explained in the business case). This dividend is a compensation for the investment farmers make via the producer organisation into the direct sugar beet processing facility. The dividend sugar beet growers will receive, varies between €5 and €8 per tonne of sugar beets delivered.

Benchmark analysis shows that producing ethanol via direct processing of sugar beets has a substantially lower per unit cost of production of ethanol than the cost associated with the conventional sugar beet processing, with crystal sugar as its major product. Moreover, the per unit costs of direct sugar beet processing are in a similar range as those obtained from alternative direct processing methodologies (US corn, Brazil sugar cane). Taking into account import tariffs and transportation cost, direct processing of sugar beets via the Beta-process is competitive to imported ethanol.

Profitability of direct sugar processing depends on the ethanol price
The profitability of direct sugar processing crucially depends on the ethanol price that can be made and the price that has to be paid for sugar beets. The obtained profitability estimates (return on investment) indicate that also with a somewhat lower ethanol price the business case will still be viable. From the background calculations made it follows that the EU ethanol price should then not be lower than 60 eurocents per litre.

Re-introducing sugar beet growing in Slovenia is possible with yields increasing to 55 tonnes/ha and a price of €30 per tonne for sugar beets
At the prevailing crop prices, sugar beet cannot compete with grain maize and ware potato. The question whether or not sugar beet growing can be re-introduced in Slovenia depends to a great extent on the opportunities that farmers see and will use to increase yields up to at least 55 tonnes/ha and the efficiency of the processor to pay a price of €30 per tonne excluding dividend. Paying a price of €30 should be in the reach of a profitable direct processing of sugar beet operation.

Improving the yield performance to 55 tonnes/ha or more poses a feasible target, both from an agronomic point of view, as well as taking into account currently realised yields in various EU member states. However, this will require directed efforts and the provision of targeted extension services to farmers cultivating sugar beets.

1 Introduction

1.1 Background and relevance

This report provides a quick scan on the feasibility of direct processing of sugar beets, and the associated re-introduction of sugar beet cultivation in Slovenia. This study was issued by the Dutch Ministry of Economic Affairs.

The sugar beet is in several respects an important and interesting crop both from a producer as well as from a consumer perspective. Sugar beets contribute to the production of sugar and biofuel (ethanol) and other green products. In doing so, it can help EU member states to satisfy their mandates (10% target of renewables in energy share by 2020, and biofuels contributing up to 8.5% of liquid transport fuels by 2020). Relative to for example sugar cane, the sugar beet delivers sugar while using much (up to 40%) less water. In case farmers have a narrow crop rotation (e.g. monoculture of cereal crops), the sugar beet is a welcome crop in the farmers' crop rotation system, where it then contributes to improving soil fertility and soil structure. In the EU regions where sugar beets are cultivated, they contribute to farmers' profits and local employment. Usually sugar beets, together with for examples potatoes, belong to the crops generating a relative high gross margin per hectare.

Sugar beets are currently grown and processed in 19 EU member States (see Figure 1). In 2012-13 the cultivated area in the EU amounted to 1.52 million hectares. Cultivation is especially prominent in the northwestern part of the EU, though not exclusively there. During the last decade the area of sugar beet cultivation has declined in the EU. EU-wide it still involves more than 148.5 thousand sugar beet growers. While the EU is the biggest producer of beet sugar in the world (50% share in world production), it still imports white sugar from other countries, among which the ACP countries.

Until 2006, Slovenia had their own sugar beet cultivation and processing. After the liberalisation of the EU's sugar policy in that year, the profitability of sugar processing came under pressure, leading to the closing down of the Slovenian sugar beet processing facility. In 2017, the EU's sugar policy will be further liberalised, which will create new opportunities and challenges to the EU's sugar sector. The quota system will be abolished, which allows farmers to re-enter sugar beet cultivation, without having the costly obligation to acquire sugar quota rights. But sugar beet cultivation for other purposes than white sugar production is already allowed, so in this case Slovenia does not have to wait until 2017 to start again.

New developments with respect to the direct processing of sugar beets, producing ethanol and/or green products, may contribute to re-establishing profitable sugar beet cultivation in areas where the production of raw sugar is not or no longer profitable. This quick scan further explores this issue for the case of Slovenia.

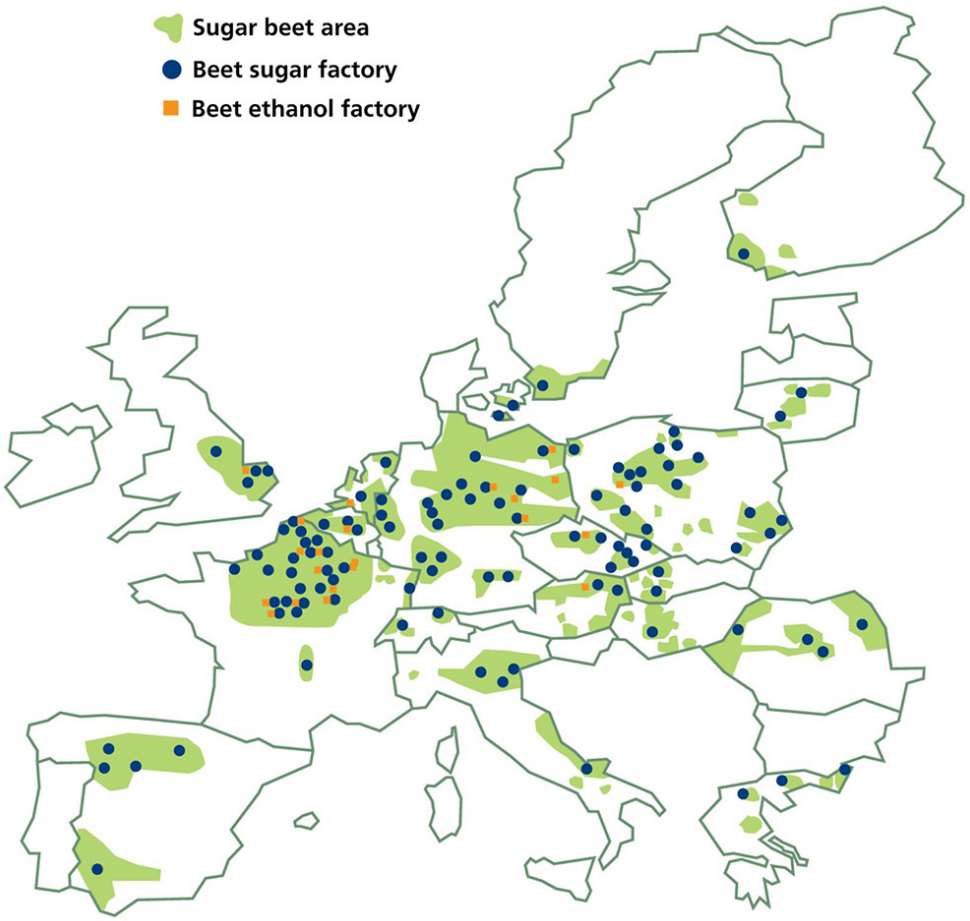

Figure 1 *Overview of locations of beet sugar cultivation areas and beet and cane sugar processing facilities in the EU (Source CEFS, 2015)*[1]

1.2 Research question

The central research question of this study is:

> *Is there a business case for direct processing of sugar beets and re-introduction of sugar beet cultivation in Slovenia?*

1.3 Structure of the research

In this study, first the planned changes in the EU's sugar policy (part of the EU's Common Agricultural Policy) and the expected market developments (including the price of ethanol) are analysed and used to derive a set of relevant prices that can be used in later calculations.

Subsequently, the business case of direct sugar beet processing, following the so-called Betaprocess, is described and analysed.

In order to have a valid business case for direct processing of sugar beets, it will be necessary to have adequate sourcing. This implies that a profitable sugar beet cultivation should be ensured. The

[1] Comité Européen des Fabricants de Sucre, see http://www.comitesucre.org/site/cefs/the-european-sugar-sector/

sourcing side is taken into account by analysing the potential of Slovenian agriculture to supply a sufficient amount of sugar beets. In this analysis both volume and price aspects are considered.

The study closes with a synthesis of the results on direct processing and sugar beet cultivation and draws a number of conclusions.

It should be noted that this study is a quick scan, providing a first assessment of the economic feasibility of direct sugar beet processing. As such this study has its limitations. For a more detailed assessment, including for example an extensive assessment of risks (sensitivity analysis, and a fully dynamic business case analysis) a follow-up study will be needed.

2 Developments in policy and markets

2.1 Introduction

In order to assess the business case for direct processing of sugar beets and the associated re-introduction of sugar beet cultivation in Slovenia, insight into the external environment is needed. This chapter discusses the planned changes of the EU's sugar policy and its impacts. Using results from the EU's medium-term market prospects and the PPS Market Outlook Agro&Food, assumptions are made on the relevant prices that will be used in the calculations in later parts of this study.

2.2 CAP policy

With the 2013 CAP reform, the EU reinforced the market orientation of its sugar policy and confirmed the abolition of the currently existing sugar quota arrangement on 30 September 2017.[2] With this reform the EU wants to make the European sugar sector more competitive at international markets. As such, this reform is a next step in the sugar policy reform process, which already started in 2006.

Abolition of the quotas on 1 October of 2017 will induce an adjustment process in which EU sugar prices are likely to converge to world market price levels. As a result, the effective price farmers will receive is expected to end up somewhere in between the current prices of within and out of quota sugar. Since a number of member states (in particular in the northwestern part of the EU) are constrained by the current regime of sugar quota (e.g. positive quota rents exist) and at the same time have out of quota sugar beet production (being still competitive at low out of quota sugar prices), these countries are likely to expand production. As a result of the expansion of EU sugar beet production, the EU demand for sugar imports is likely to decline. Or stated otherwise: due to the sugar policy reform, the EU sugar sector is becoming more self-sufficient and market oriented.

2.3 Market developments

The abolition of the quotas at the end of 2017 is expected to lead to an increase in sugar beet production from 113 to 115m tonnes (+1.5%) over the period 2016-2020. According to medium-run projections, the demand for ethanol in the EU will increase, at least up till 2020. This creates possibilities for the production of ethanol from sugar beet, wheat and other cereals.[3] Isoglucose use is expected to increase significantly to about 12% of the sweetener use (see Figure 2).

[2] See Regulation (EU No 1308/2013) for further details. See also the complementing Council Regulation 1360/2013.
[3] The projection presumes the existing technology and might underestimate the impact and potential of new direct sugar processing technologies.

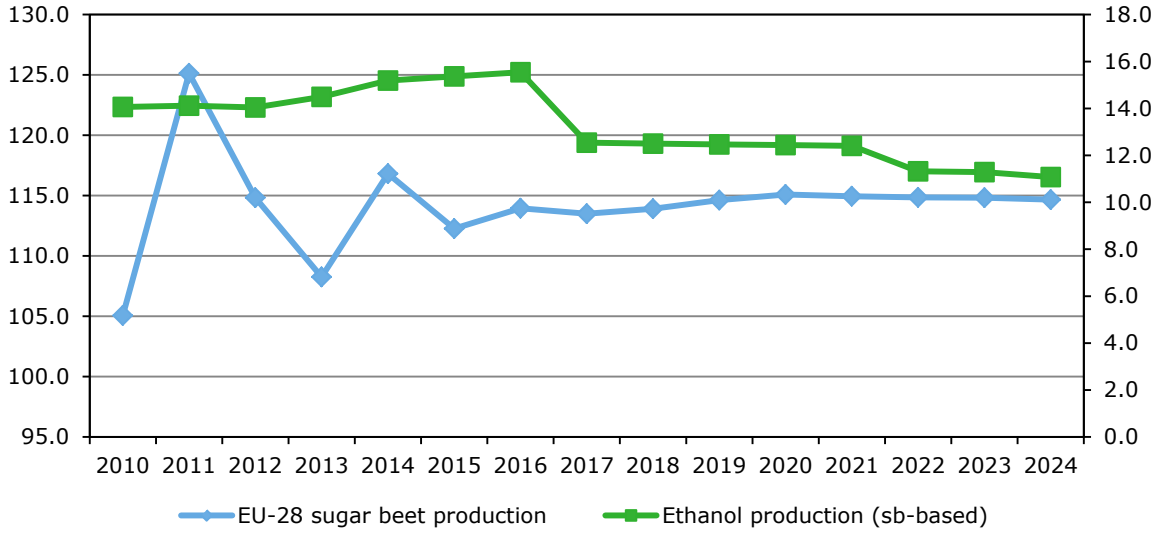

Figure 2 *Medium-run prospects of EU sugar beet and ethanol production (1,000 tonnes)*
Source: Agmemod, own calculations.

2.4 Prices

The abolition of the sugar quota in 2017 implies a structural change in the EU sugar market, which will also affect the price structure in the sugar sector (see Figure 3). The most prominent effect anticipated is convergence between the EU and world market prices of white sugar; the current price gap of over €200/t is expected to close to about €50/t (EU Commission, 2014). This could result in a domestic price that is only slightly above €400/t by 2019. The sugar policy reform will also affect the average EU price for sugar beets (-7%).

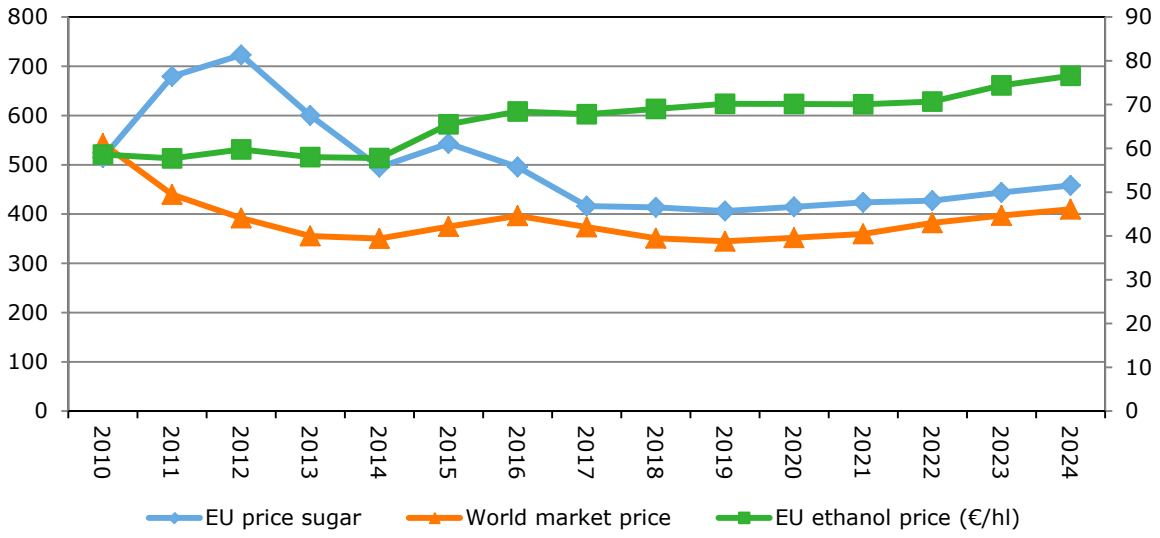

Figure 3 *EU and world market sugar and ethanol medium-run price prospects in euro/t (ethanol price on right axis in euro/hectolitre)*
Source: Agmemod, own calculations.

Prices of other crops are provided in Figure 4. As can be seen from this figure, the cereals show a relative price decline as compared to sugar. The price of ethanol is projected to increase by about

13% in the period 2016-2024. This price projection is strongly policy driven, where it has been assumed that, with respect to bioenergy use:

- a 10% target of renewables in energy share by 2020 will be held
- biofuels are supposed to contribute to 8.5% of liquid transport fuels by 2020.

For the medium-run future, a growing demand for ethanol is foreseen, which will lead to an increase in prices.

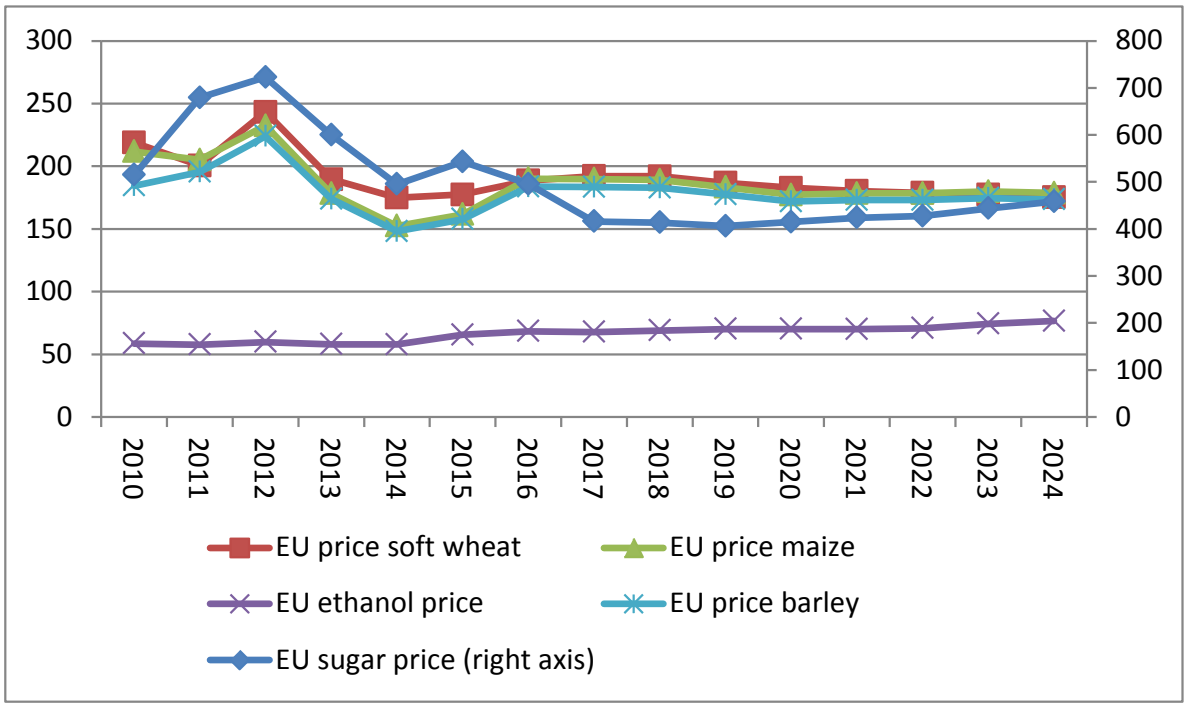

Figure 4 *EU cereals, sugar and ethanol price prospects (euro/tonne)*
Source: Agmemod, own calculations.

Table 1 provides an overview of the prices for selected crops in euro/tonne (refers to EU averages). Averages are calculated for two periods: the period before and after the (new) liberalisation of the EU sugar market (2017). The EU sugar support price currently is about €400/t. For our forward looking exercise, taking a sugar beet price of €27/t seems a reasonable assumption (estimate). This EU average price is an average including the price that is achieved in member states having white sugar production. In the past decade, the prices for common wheat and barley in Slovenia were usually a bit (+5% and +8%) higher than the EU averages, while for maize it has been lower (-10%).

Table 1
Price prospects for selected crops (EU average)

	Average projected prices	
Price (€/t)	**2010-2016**	**2018-2024**
Sugar	579	427
Ethanol (€/hl)	61	72
Sugar beet (estimate)	29	27
Common wheat	199	182
Barley	181	175
Maize	190	181

Source: Agmemod, own calculations and EU Commission (2014).

Note that according to the outlook projections, the EU sugar policy reform will lead to a significant decline in the EU price of sugar by more than 25%. At the same time, the price of ethanol is expected to increase from €61/hl to €72/hl (or + €11/hl to +18%), thereby increasing the relative attractiveness of bioenergy production (see also EU Commission, 2014).[4] The projected wheat and maize prices decline by about €10 per tonne in the period 2018-2014, relative to the period 2010-2016. However, they are still at a higher level than in early 2000.

2.5 Conclusion

Up to now the sugar sector has been strongly regulated, with a policy arrangement that affects the price structure in the EU's internal market. However, it has been announced that as of October 2017 this sugar policy is to be dismantled.

As a result of the CAP's sugar policy reform, it is expected that the EU sugar price will decline by about 25%, whereas the price of ethanol is expected to rise by about 15%. The ethanol price is strongly policy driven. For the cereal prices, a modest price decline is foreseen.

For the assessment, the following prices will be used, taking into account sugar policy reform, market perspectives at EU level (averages), and local circumstances (based on deviations of Slovenian price patterns from the EU as observed in the past):

- Common wheat €191/t.
- Barley €189/t.
- Maize €172/t.
- Sugar beet €27/t.
- Ethanol €72/hl.

The increased market orientation of the CAP implies that EU prices will more closely follow world market prices and are also likely to be more volatile than in the past. Also the link with energy markets (via the demand for biofuels) has become stronger over time.

[4] EU Commission (2014) *Prospects for EU agricultural markets and income 2014-2024*. Brussels, DG-Agriculture and Rural Development, December, 2014.

3 Direct processing of sugar beets (the Betaprocess)

3.1 Introduction

'Direct sugar beet processing', and the technologies that are developed for this, create an alternative opportunity for sugar beet cultivation. One of these alternative technologies is the Betaprocess technology, with a pilot facility already running in the Netherlands (Lelystad). A crucial question that needs to be answered is whether and under which conditions this technology creates an attractive business case, in particular in Slovenia. In this chapter that issue is further explored, where the price signals derived in the previous chapter will be our point of departure for the calculations. For the calculations a simple tool is used, which represents the economic side of the Betaprocess technology. The parameters in this tool are calibrated on results obtained from the experimental demonstration facility in The Netherlands. The calculation tool allows for variation in crucial parameters and for comparing different assumptions and scenarios.

The direct processing approach differs from the standard sugar processing model. Traditionally, the sugar beet was mainly seen as a resource of white sugar. The sugar beet, however, is a multipurpose crop, which can be used for several other purposes. Recently, there has been a growing interest from a wide range of industries for sugar as a potential building block for bio-based products. In BBE concepts, the sugar beet crop starts to play an important role, e.g. for purposes like cosmetics, nutraceuticals, drinking alcohol, fuel, etc. Figure 5 illustrates the difference between the two methodologies. On the right side of the figure, the conventional path is illustrated, with sugar as a main product and bio-based by-products; the latter are produced after a refinery step, using the waste streams from sugar production. The left side of the figure shows the direct processing of sugar beets, through which bio-based products can be processed immediately.

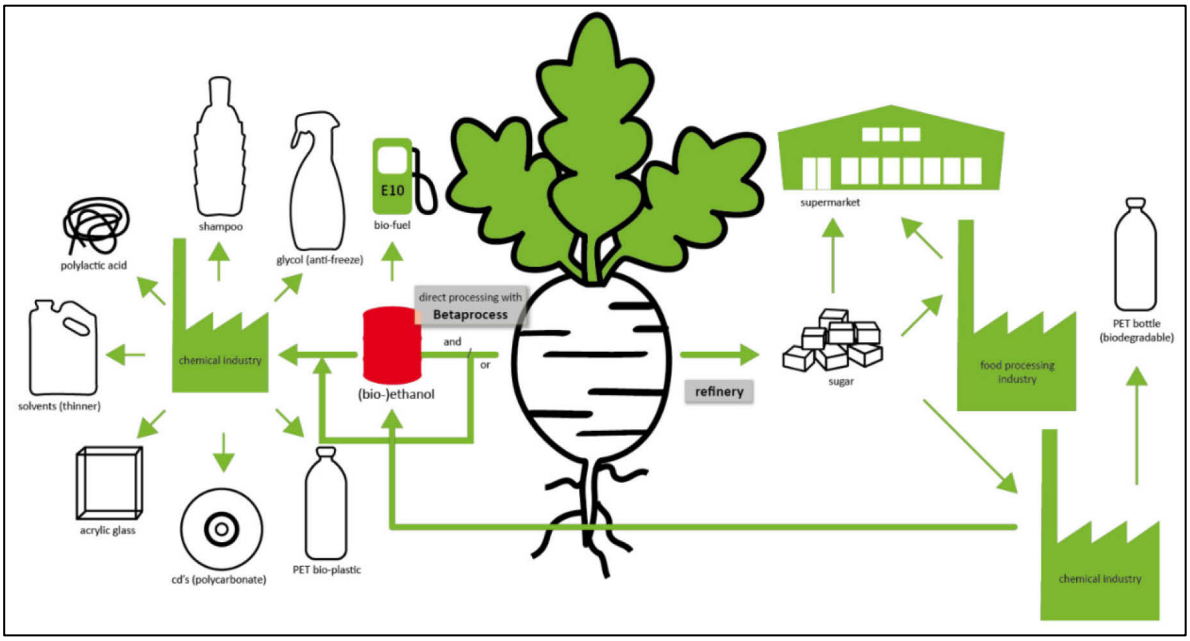

Figure 5 *The sugar beet as a multipurpose crop for bio-based products (on the right, the traditional sugar production, with BBE products as by-products; on the left, direct processing, with e.g. bio-ethanol as main product)*

Conventional processing of sugar beets into white sugar is a well-known process. During the process, side streams are used for processing materials into e.g. ethanol. But this is all cost price-wise not so attractive. A new approach is direct processing, enabling the processing of sugar beets into green products with efficient process steps, lower transportation costs, and less energy use. This alternative methodology will be discussed in the next section.

3.2 Description direct processing with the Betaprocess technology

Compared to conventional the process, the direct processing methodology distinguishes itself by immediate processing the sugar beet, skipping the usual pre-treatment stages in white sugar production. Figure 6 illustrates the route from sugar beet to green products using the direct processing methodology.

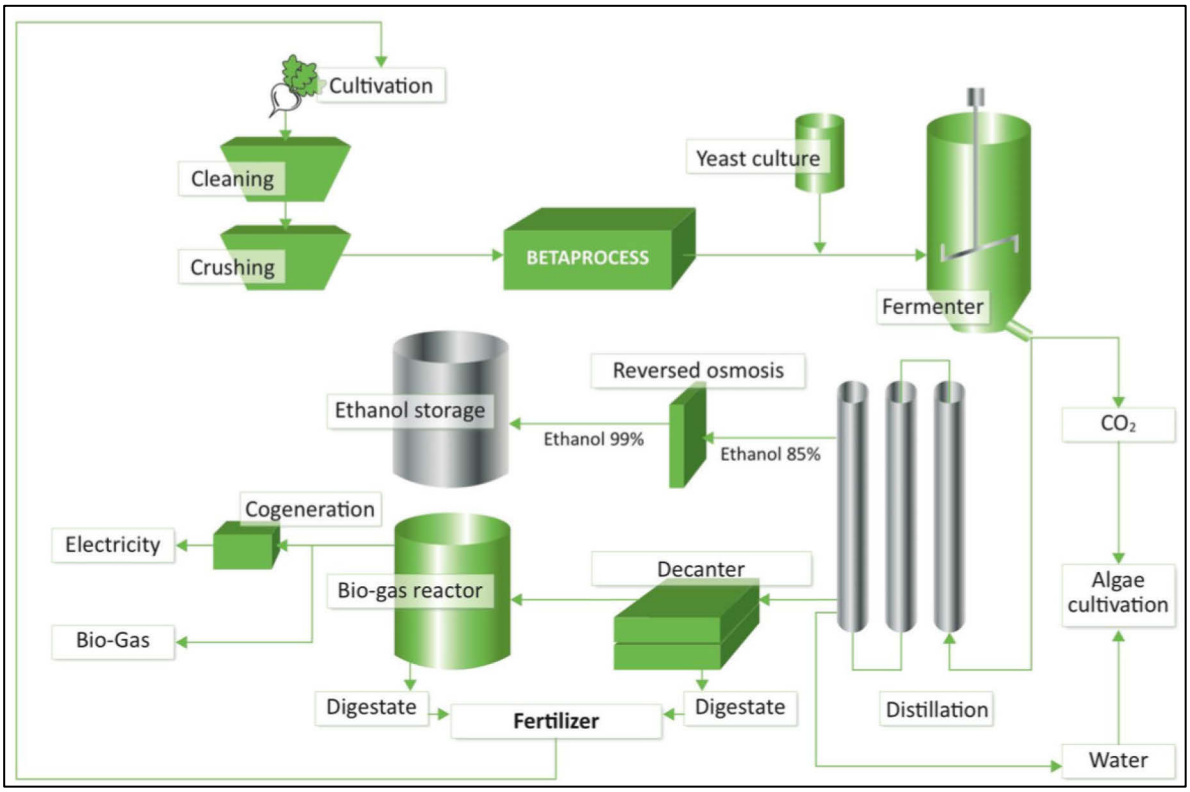

Figure 6 *Direct processing methodology: process flow*

The pre-treatment stage (washing, cutting, crushing) ends with a vacuum extrusion stage through the Betaprocess technology.[5] Crushed biomass is brought into a reaction vessel, where a reaction takes place under vacuum conditions at a temperature between 60 and 70°C. During this reaction, the cells of the biomass material 'explode', meaning the fibres, cell walls and cell membranes are ripped apart, so that bacteria and enzymes obtain direct access to the sugars and other cell ingredients. Moreover, this explosion causes a change in the molecular structure of different substances and their release. This effect facilitates and accelerates massive bacterial activity, fermentation, and thereby the formation of ethanol. This results in a much more efficient production process, generating higher ethanol yields compared to conventional methodologies of producing ethanol from thick juice or molasses.

[5] See also Box below for more details about the DSD company, which further commercialises this technology.

Box Dutch Sustainable Development BV (DSD) & Betaprocess

DSD is an internationally operating technology developer specialised in managing projects concerning sustainable agriculture, the food processing industry and the bio-based economy. Based in the Netherlands, the company has a background in the sugar industry and is responsible for the marketing and sales of the Betaprocess technology. After initial development by Dreier Oenotech, Mr Steiner and Syngenta (Switzerland), DSD has continued the development of Betaprocess towards the commercial stage. DSD collaborates with specialists and partners such as Wageningen UR, Acrres, UWM (Poland), VAM Watertech and UCR.

Because direct processing disintegrates the cell structure of the biomass material in just a fraction of a second, direct access is obtained to these most valuable substances. By doing this, the direct processing methodology offers great opportunities in many areas. One important advantage of direct processing over conventional methodologies is that it results in a higher yield for ethanol production of 10% to 13% per tonne of sugar beet (see Figure 7). This effect is the result of the cell explosions in the Betaprocess stage, through which direct access is obtained to the sugars. In addition, the process allows for shorter fermentation time and fermenting without enzymes. Combined, these advantages result in 10% to 20% lower investment costs per tonne of ethanol compared to alternative methodologies.[6]

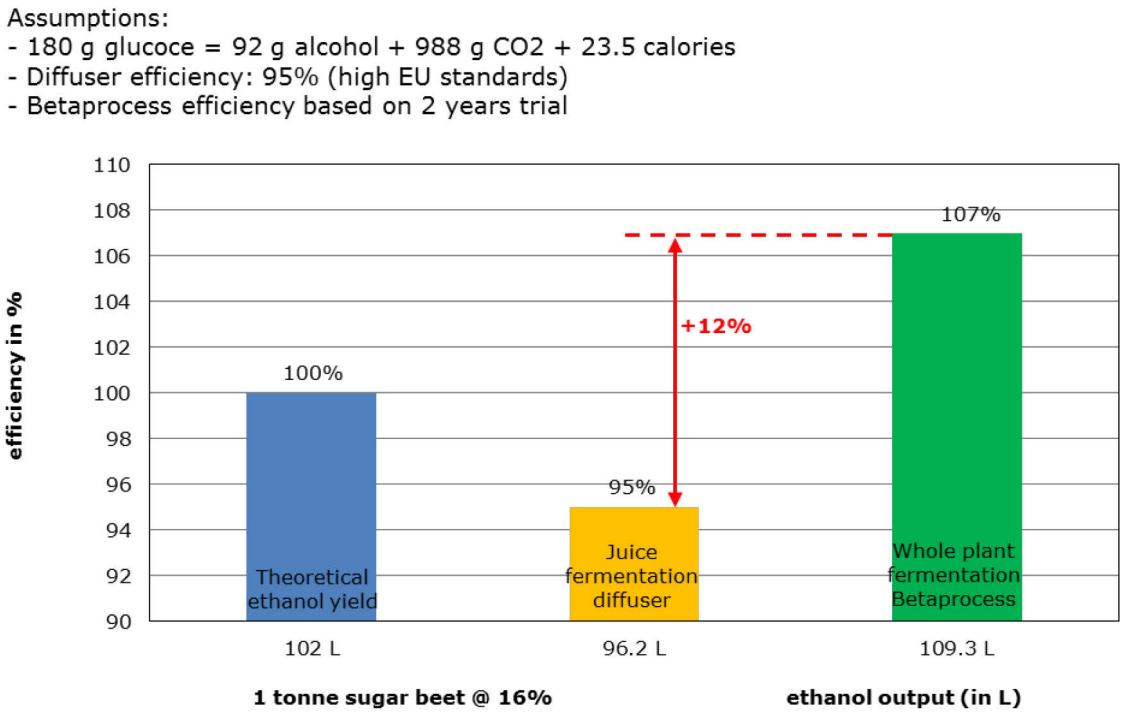

Figure 7 *Increased yield of ethanol production through Betaprocess relative to conventional sugar beet processing*

Direct processing can be carried out as close to the source as possible. Depending on the available acreage, direct processing units could be installed within a radius of 10-25 km of the farming area - resulting in local production of bio-based products.[7] This characteristic offers interesting opportunities for the agricultural sector, because the farmers will be able to play a much more important role in

[6] A more detailed technical explanation of the methodology is available with the authors and can be obtained on request.
[7] The exact scale and capacity of a local unit depends on local circumstances and will be subject to further research.

relatively small-scale production of highly qualified components and chemicals. They can adopt the new approach as a producer organisation, which offers the opportunity to realise high savings on transportation and storage costs compared to traditional sugar beet processing.

3.3 The business case

In this paragraph, the conditions for an economic sound business case for a direct processing facility are analysed (see Table 2 below). Three scenarios are analysed, applying different beet prices per tonne. In all cases, the expected market price of ethanol (as found in the previous chapter) is set at €0.72 per litre (see Table 1).

Furthermore, the calculations assume a factory campaign length of 125 days. The daily processing capacity is 3.200 tonnes of sugar beets. The total amount of sugar beets annually processed is 400,000 tonnes. Assuming a sugar beet yield of 50 tonnes per hectare (and no losses), this implies that a minimum amount of 8,000 ha of sugar beets should be cultivated (see next chapter for more details under which conditions this is feasible).

A shareholders equity rate of 30% is assumed. Dividend pay-out is assumed to be 50% of total profits, of which in turn 50% will be allocated to the farmer organisation, who owns the processing facility. The first scenario assumes a beet price of €27 per tonne, which is in line with the expected market price as found in the previous chapter. Using this sugar beet price, the calculation tool representing the economics of the Betaprocess generates ethanol production costs of €0.43 per litre. Based on this figure, the business case results in a calculated return on investment of 24.7%. The expected gross revenues for a farmer would be around €1,736 per hectare - including the beet returns of €1,350 per hectare and a share of the dividend (€386 per hectare).

In addition to the first scenario, a second and third scenario were analysed, in which higher prices for sugar beets were assumed. The reason was that a price of €27/t might be too low to make sugar beet cultivation sufficiently profitable for the farmers. In that case the sourcing of the assumed amount of 400,000 tonnes of sugar beets would be at risk (see further details in the next chapter). In the second and third scenario sugar beet prices of €30 and €35 per tonne respectively were assumed. As our calculations show (see Table 2), in this case the return on investment would be within the range of investor preferences, namely between 18,3% (third scenario) and 22,3% (second scenario). These returns are still above the minimum threshold of 15% and indicate a sufficient profitability for the investors.

Table 2

Results of a business case assessment of Betaprocess for ethanol (EtOH) production

	Scenario 1	Scenario 2	Scenario 3
Beet price per tonne	€27	€30	€35
Cost per litre EtOH	€0.43	€0.45	€0.50
EtOH price/litre	€0.72	€0.72	€0.72
Annual turnover	€30,240,000	€30,240,000	€30,240,000
Profitability *)	€12,341,867	€11,141,867	€9,141,867
Total dividend a)	€6,170,934	€5,570,934	€4,570,934
Dividend farmers b)	€3.085.467	€2,785,467	€2,285,467
Dividend farmer per tonne c)	€7.71	€6.96	€5.71
Dividend farmer per hectare d)	€386	€348	€286
Total income farmer per ha e)	€1,736	€1,848	€2,036
Return on investment f)	24.7%	22.3%	18.3%

* Season 125 days, cash payment 30% of total investment

Assumptions: a) Total dividend is 50% of total profits; b) Dividend farmers is 50% of total dividend; c) Dividend farmers divided by annual plant production (3,200 tonnes per day * 125 days production); d) Dividend farmer per tonne * yield per hectare (50 tonnes); e) Beet income per hectare + dividend farmer per ha; f) Profit/total investment (€50m).

Table 3 below provides an illustrative overview of per unit cost of production (cost price) of ethanol as produced from several feedstocks. The comparison includes the calculated scenarios of direct sugar beet processing using the Betaprocess technology. The comparison shows that direct processing results in much lower per unit cost of production of ethanol than in the case of conventional sugar beet processing (about 40% lower). The per unit cost of production of ethanol of both direct processing scenarios is slightly higher than the estimates obtained by DSD for US corn and Brazilian cane sugar. However, it should be noted that in the two latter cases, import duties and transportation costs are not included. The import tariff on ethanol is currently about 0.19 euro/litre. This implies that under the current conditions producing ethanol for direct processing of sugar beets (as represented by the scenarios developed in this study) is competitive compared to imports from outside the EU.

Table 3

Per unit cost of production (EtOH/litre) of alternative ethanol production technologies

Source	Cost price of ethanol production (euro/litre)
Sugar beet (conventional)	0.80
Direct processing scenario 3	0.50
Direct processing scenario 2	0.45
Direct processing scenario 1	0.43
Corn (US)	0.42
Cane sugar (Brazil)	0.35

Source: DSD, 2015.

3.4 Conclusions

- Scenario analysis shows that, taking into account future expected market conditions, cultivating sugar beets for ethanol production using the Betaprocess direct processing technology provides a profitable business, given that some side conditions are satisfied. The business case has a commercially acceptable positive return on investment when paying a market price for sugar beets between €30 to €35 per tonne.
- Direct processing creates a two-level income contribution for sugar beet growers, i.e. (1) as a sugar beet producer and deliverer of the beets to the factory, and (2) as a shareholder of the factory, receiving dividend from the farmer organisation (as explained in the business case). This dividend compensates the investment costs farmers make via the producer organisation into the direct sugar beet processing facility. The dividend sugar beet growers receive, varies between €5 and €8 per tonne of sugar beets delivered.
- Benchmark analysis shows that producing ethanol via direct processing of sugar beets has a substantial lower per unit cost of production of ethanol than the cost associated with the conventional sugar beet processing. Moreover, the per unit costs of direct sugar beet processing are in a similar range as those obtained from alternative direct processing methodologies (US corn, Brazil sugar cane). Taking into account import tariffs and transportation costs, direct processing of sugar beets via the Beta-process is competitive to imported ethanol.
- The profitability of direct sugar processing crucially depends on the ethanol and sugar beet prices. The profitability estimates (return on investment) indicate that with a somewhat lower ethanol price than assumed in the calculations, the business case will still be viable. However, the EU ethanol price should then not be lower than €0.60 per litre.

4 Farm economics of sugar beet cultivation

4.1 Agronomic situation in Slovenia

Slovenia holds 2m hectares of land in total. More than half of that area is covered by wood and almost 40% is used for agriculture. The farmland area consists for more than 60% of permanent grassland and of about 30% of arable land. Half of the arable land is used for cereal growing, mainly maize and wheat. Seven percent of the farmland is covered with vineyards.[8] For this study, a major estimation is that about 600,000 ha of farmland is arable land and that cereals are important crops to deal with if Slovenia would like to re-introduce sugar beet growing. Purely from a rotational point of view, sugar beet could cover 25% of the arable area, being 150,000 ha. However, in practice much lower areas are available for sugar beet growing, due to restrictions as stones, slopes, soil quality, etc.[9]

Until 2006, Slovenia had a sugar beet processing plant, producing white sugar. In that year, the great European Sugar Reform resulted into the decision to sell the national sugar quotas to the EU and quit sugar beet growing and processing. Between 2000 and 2006, the Slovenian sugar beet area (harvested area) varied between 4,450 and 8,116 ha (with an average of 5,582 ha; FAO Database). The yield in this period varied between 37.4 and 52.2 tonnes/ha (average: 43.6 tonnes/ha, FAO Database). The (unweighted) average price paid in the same period was €35.30 per tonne (varying between €30.00 and €44.10 per tonne), resulting in (unweighted average) gross returns of €1,570 per ha (FAO Database). For comparison, the (unweighted average) gross returns per ha in the same period were €556, €446, €748 and €2,813 for wheat, barley, (grain) maize and ware potatoes (FAO Database).

4.2 Method for evaluation of the competitiveness of sugar beet growing

Farmers' decisions on the cropping plan on their farms are strongly influenced by cost-benefit calculations or expectations. Agronomic opportunities and limits determine the crops to select between, like soil fertility, the availability of water, the presence of stones in the soil and the risks of soil-borne diseases. But also the opportunities to deliver the products to a processor, to a chain partner or (directly) to consumers play an important role in the decision which crops to grow to which amount on which fields etc. Within a given context of farm equipment, agronomic restrictions and selling opportunities, the gross margins of the different potential crops are the major criterion for crop selection. In the next paragraph, a comparison of gross margins for sugar beet and other crops in Slovenia is presented.

In this case of (renewed) sugar beet growing, gross margins are not sufficient for a complete evaluation of the competitiveness of sugar beet compared to other crops. Additional information is required on long-term investments in equipment, machinery and storage by farmers or contract workers. Sugar beet harvesting requires specific machinery, which are most probably not present anymore on the farms or with contract workers in the country. Investments have to be made and paid off, resulting in significant additional costs for the farmer, directly when the farmer does the investment himself, or indirectly, via contract tariffs, when the contract worker does the investment as

[8] http://ec.europa.eu/agriculture/publi/peco/slovenia/summary/sum_nl.htm
[9] Note that in the previous chapter a minimal amount of 8,000 ha of sugar beet cultivation has been assumed.

a service for the farmers.[10] For a complete evaluation of the costs, the direct costs (e.g. seed, fertilisers, pesticides) and the fixed costs (mainly machinery and labor, possibly combined in contract work) have to be estimated.

For the other part of the evaluation, the benefits of renewed sugar beet cultivation, estimations have to be carried out for the yield of sugar beet growing in Slovenia (root yield and sugar content) and the price paid by the processing industry. Since sugar beet has not been grown in Slovenia since 2006, yield predictions have to be carried out based on historic data with corrections for yield developments since 2006 in other crops in Slovenia. Price estimations have been carried out in the paragraph on market outlook results. However, the price paid[11] is also a result of the performance of the sugar beet processor. If the processor appears to reach both a high processing efficiency and a high selling price of the product, e.g. ethanol, then the price for the farmer can be higher than when the efficiency and/or the price performance are less favorable. The profitability and competitiveness of the crop can be improved when either the yield or the sugar content or the price paid increases and/or the costs can be reduced.

The re-introduction of sugar beet as a dicotyledonous crop in a cropping plan with mainly cereals (monocotyledon crops) could positively influence the condition of the soil and improve the yields of the cereals. A good estimation of such an effect is hard to make and is not carried out in this quick scan. An investment in a direct processing plant can become more profitable through an increase of the length of the campaign (keeping the daily amounts of biomass processed constant). Since a lot of maize is grown in the country, that crop could be used as an additional biomass source for direct processing after the sugar beet campaign, with possibly even contributions from waste products from e.g. the food industry. Such measures could decrease the fixed costs per hl ethanol and thus strengthen the business case of such an investment. However, this quick scan did not intend to give a full description and analysis of additional advantages of sugar beet growing and additional opportunities of direct beet processing. Therefore, calculations have not been carried out to quantify such advantages and opportunities, although they could strengthen the business case.[12]

4.3 Results of the evaluation

4.3.1 Basic evaluation

Table 4 shows the results of a comparison of gross margins of sugar beet and competing crops. The returns and gross margins of wheat, barley, grain maize, ware potato and sugar beet were derived with a set of data on yields, direct costs and prices, either calculated or estimated.[13] The data presented show that in case of sugar beet yields of 50 tonnes per ha, direct costs of €1,000 per ha and a price paid of €29 per tonne (see Table 1 but with a higher price for sugar beet in the past than predicted for the coming period), sugar beet gives the farmer a margin higher than wheat and barley but lower than grain maize and ware potato. This is more or less the picture when sugar beet would be re-introduced in the current situation in Slovenia and with the coefficients assumed.

[10] Alternatively, a producer organisation (owned by farmers) can decide to do the investments for their members. If organised well, this can result into a lower tariff per ha sugar beet than when individual farmers or contract workers have to do these investments.

[11] Dividend was considered as a reward for rents (investment costs) and delivery security by the sugar beet growers, and therefore not included in the gross margin calculations presented.

[12] A full description could also include negative effects of sugar beet growing, e.g. lower cereal yields after sugar beet harvests under wet conditions. These effects have not been quantified in this quick scan either.

[13] Fixed costs for machinery and labour are not included in this comparison. For a first impression, the sugar beet harvest in the Netherlands costs about €150 per ha more than the cereal harvest (contract work tariffs).

Table 4

Farm-economic estimations for arable crops in Slovenia in 2009-2013 a)

Crop	Yield (kg/ha)	Direct costs (euro/ha) b)	Price (euro/tonne) c)	Returns (euro/ha)	Gross margin (euro/ha)	Area in 2009-2013 (ha)
Wheat	4,747	669	199	945	276	32,498
Barley	4,212	442	181	762	321	18,315
Grain maize	7,512	893	190	1,427	534	39,250
Ware potato d)	23,586	1,620	183	4,316	2,696	3,727
Sugar beet	49,916	1,021	29	1,448	427	0

a) The assumptions and calculations behind these data are given in Appendix 1;

b) Based on data of the Agricultural Institute of Slovenia; direct costs are defined as the costs of seed, fertiliser, crop protection, energy (drying), crop analysis and crop insurance;

c) Market outlook data, based on EU average (no country specific corrections applied); d) price of ware potato based on FAO database.

4.3.2 Future situation with projected sugar beet prices

Table 5 shows the expected situation in the coming years, based on the same coefficients as in Table 4 but with projected prices from market outlook studies (See Table 1, prices for period 2018-2024).

Table 5

Farm-economic estimations for arable crops in Slovenia in 2018-2024 a)

Crop	Yield (kg/ha)	Direct costs (euro/ha) b)	Price (euro/tonne) c)	Returns (euro/ha)	Gross margin (euro/ha)
Wheat	4,747	669	182	864	195
Barley	4,212	442	175	737	296
Grain maize	7,512	893	181	1,360	467
Ware potato	23,586	1,620	183	4,316	2,696
Sugar beet	49,916	1,021	27	1,348	327

a) Yields and direct costs as in Table 4, also price of ware potato; other prices from market outlook (see Table 1).

Since the prices assumed for all crops except ware potatoes in the coming years are lower than in the current situation (Table 4), the gross margins of all crops will decrease. Under these conditions, sugar beet is still less attractive than grain maize (and ware potato). The situation will only improve when the sugar beet yields and/or prices assumptions are set higher.

4.3.3 Sensitivity analysis

In order to investigate the perspectives of a re-introduction of sugar beet growing and processing, a closer look to the yield and price of sugar beet was taken (Table 6):

a. According to scenario 3 of the business case, it should be possible to pay the farmers a sugar beet price of €35 per tonne instead of €27 or €30 per tonne. This would bring the gross margin of sugar beet at the level of grain maize (€470);
b. There is evidence that yield improvement in sugar beet is significantly stronger than in other arable crops. As an example, average sugar beet yield in the Netherlands increased between 2000-2004 and 2009-2013 from 61.4 to 78.2 tonne/ha on average, which is an increase of 27.2%. Applying this increase rate in yield on the Slovenian data would result into a yield of 55.4 tonne/ha, giving a similar gross margin, but with a sugar beet price of €27 per tonne;
c. A yield of 55.4 tonne/ha combined with a price of €30 per tonne would make sugar beet clearly more attractive than cereals and grain maize.

Table 6

Farm-economic estimations for arable crops in Slovenia in 2018-2024 with adapted yields and/or prices for sugar beets a)

Crop	Yield (kg/ha)	Direct costs (euro/ha) b)	Price (euro/tonne) c)	Returns (euro/ha)	Gross margin (euro/ha)
Wheat	4,747	669	182	864	195
Barley	4,212	442	175	737	296
Grain maize	7,512	893	181	1,360	467
Ware potato	23,586	1,620	183	4,316	2,696
Sugar beet b)	49,916	1,021	30	1,497	477
Sugar beet c)	55,422	1,021	27	1,496	476
Sugar beet d)	55,422	1,021	30	1,663	642

a) Yields and direct costs as in Table 2, also price of ware potato; prices from market outlook except for sugar beet;

b) Adapted beet price, according to scenario 2 of the business case;

c) Original beet price, according to scenario 1 of the business case, and adapted sugar beet yield;

d) Adapted beet price, according to scenario 2 of the business case, and adapted sugar beet yield.

Model calculations as presented are to a large extent influenced by the input data assumed, as illustrated through the sensitivity analysis provided in Table 6. The major question is now: which yield and price levels are realistic and give a good basis for a realistic vision on the costs and benefits of the re-introduction of sugar beet growing and processing?

4.4 Conclusion

At the prevailing crop prices, sugar beet cannot compete with grain maize and ware potato. The question whether or not sugar beet growing can be re-introduced in Slovenia depends to a great extent on the opportunities that farmers see and will use to increase yields up to at least 55 tonne/ha and the efficiency of the processor to pay a price of at least €30 per tonne excluding dividend.
As was concluded earlier from the business case description of the Betaprocess as discussed in Chapter 3, paying a price of €30 should be in the reach of a profitable direct processing of sugar beet operation.

Improving the yield performance to 55t/ha or more poses a feasible target, both from an agronomic point of view, as well as taking into account currently realised yields in various EU member states. However, this will require directed efforts and the provision of targeted extension services to farmers cultivating sugar beets.

5 Synthesis and conclusions

This study on the business case of direct processing of sugar beets, using the Betaprocess technology, and the associated re-establishment of sugar beet cultivation in Slovenia consisted of three steps:

1. An inventory of expected future developments in policy and relevant agricultural markets with the aim to derive a set of reliable prices, conditioning the business environment of a potential direct sugar beet processing supply chain.
2. An assessment of the business case of direct sugar beet processing, taking into account the expected future market environment.
3. An assessment of sugar beet cultivation in Slovenia with a particular emphasis on the conditions under which an adequate supply (taking into account the minimum scale of a direct processing facility) of sugar beets will be produced. Factors taken into account are the prices of sugar beet and alternative (competing) crops, suitability of land, crop yields in tonnes of sugar beets per hectare as well as the sugar content of the beets, costs for cultivation and harvesting, etc.

From this quick scan it is concluded that, under the expected future market developments, there is a profitable business case for direct processing of sugar beets and the re-establishment of sugar beet cultivation in Slovenia under the condition that:

- the direct processing stage of the sugar beet supply chain will pay a market price to sugar beet growers that is sufficiently high to guarantee the supply of sugar beets of 400,000 tonnes.
- a price of €30/t will be paid for sugar beets, and Slovenian farmers succeed to increase yields up to at least 55 tonne/ha (latest and dated production figures indicate a production of about 50t/h, implying a 10% yield increase).

The assessment showed that the direct processing of sugar beets will still be profitable in case a price for sugar beets of €30/t has to be paid (the associated return on investment then is 22%, which exceeds the threshold value of 15%). Moreover there is evidence that when a price of €27/t of sugar beets will be paid, it still might be sufficiently high to induce arable farmers to include sugar beets into their crop rotation and supply a sufficient amount of beets for the processing facility to run at full capacity. But that case would certainly require moderate cultivation costs, which could be realised through e.g. cooperative investments in harvest equipment. This would even lead to a higher profitability of direct processing of sugar beets itself.

It should be noted that the results obtained in this study are subject to various uncertainties, which are indicated in the analysis. Uncertainties have been mentioned with respect to the price of ethanol (strongly policy driven), the feasible sugar beet yield per hectare, and other factors. A more detailed assessment of the uncertainties was beyond the scope of this quick scan, but could be recommended as a future step.

This feasibility study is a quick scan, implying that no extensive analysis could be made. This research focuses on key economic aspects, and derived results based on following a procedure as has been described. No in-depth study has been made on institutional or organisational aspects. Implicitly it has been assumed that the investment in direct sugar beet processing will be done by a new cooperative, which will raise capital or equity from its members as well as from external investors.

Appendix 1 Reasoning and assumptions behind Table 4

Table A.1 gives statistical data on yields, areas, gross margins and direct costs in Slovenia, in as far available from our data sources. In the period 2000-2004, Slovenia had an average sugar beet area of almost 5,500 ha, with an average yield of about 43.5 tonne/ha, average direct costs of €850 per ha and a Standard Gross Margin (SGM) of €871 per ha. The SGM for sugar beet was €370-€470 higher than for cereals (not taking harvest costs into account). Thus, sugar beet was an attractive crop at that time.

Table A.1

Statistical data for Slovenia

Crop	Average yield (kg/ha)		Yield increase (%) a)	Average SGM (euro/ha) b)	Average area (ha) 2009 - 2013 c)
	2000-2004	2009-2013			
Wheat	4,347	4,747	9.2	500	32,498
Barley	3,488	4,212	20.8	401	18,315
Grain maize	6,462	7,512	16.2	495	39,250
Ware potato	20,805	23,586	13.4	2,138	3,727
Sugar beet	43,566	49,916 d)	14.6 d)	871	0

a) Increase of average yield level per crop between the two periods, 2000 - 2004 and 2009 - 2013, expressed in a percentage of the period 2000-2004. Source: FAO database;

b) SGM-values (Standard Gross Margin) were only available for 2000, 2002 and 2004 in FADN (not for 2001 and 2003);

c) Source: FAO database. In the period 2000-2004, Slovenia had an average sugar beet area of 5,466 ha and an average price paid of €35.3 per tonne of sugar beet;

d) Since sugar beet was not grown in Slovenia in the period 2009-2013, a hypothetical yield of sugar beet was estimated, based on the weighted average yield increase of the four other crops in the table, being 14.6%.

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