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A roadmap to develop Integrated Biomass Logistic Centres in Skåne Sweden - Case study grain milling industry

Justin Casimir and Johanna Lund

RISE Report 2020:39



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Abstract

This report presents the results from the EU project AGROinLOG (Grant Agreement 727921) and focuses on the development of a roadmap for the grain processing industry to develop Integrated Biomass Logistic Centres in Skåne. More information concerning the Swedish contribution can be found in the public report AGROinLOG (2020a).

The Swedish partners of the AGROinLOG project have been interacting with different stakeholders from the grain processing industry in Skåne (South of Sweden) to investigate the existing hindrances and drivers for the development of Integrated Biomass Logistic Centres (IBLC) in the region. This report focuses in particular into the milling industry in Skåne in regard to its potential, the utilization of the by-product bran and limitation for the implementation of IBLC. The objective of this report is to propose a roadmap for the transformation of the current milling sector into an IBLC.

The reader will first get a brief introduction to the IBLC concept and a detailed status of the cereal production and milling industry in Skåne. The process for data collection included many interactions with the industry and other relevant stakeholders. The results are then presented.

The roadmap uses a backcasting approach starting with the development of a desired sustainable vision of the future. The vision foresees that mills have developed into IBLCs and collaborate with many actors to produce a wider range of products and add values to other by-products than the mills' own by-products. This new activity is profitable for the mills but also for other processing industries. The products developed are highly demanded by the consumers.

The authors then mapped the current situation looking in particular at hindrances, potential conflict of interest, and policy support. The hindrances could be clustered into six categories: supply, communication, regulation, economy, market, and logistic. The conflict of interest for the valorisation of bran is low as it is used for human consumption to a low extent. It could however conflict with the animal feeding industry. Different kinds of supports are needed at the different stages of the innovation development. Skåne, and Sweden in general have good access to supporting schemes. More technical data concerning the current status of the milling sector is included in the background chapter.

Finally, concrete measures for moving from the current situation to the vision are discussed. The most important measure to implement would be to develop a market for the new bio-based products. To support this, a number of measures should be implemented in a joint effort. These measures include technical development, collaboration, and communication. Moreover, sustainability must be a red thread in this transformation, and new legislation should provide a supportive framework.

Key words: Roadmap, Grain sector, Milling industry, Bran, IBLC, Bioeconomy

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Sammanfattning

I denna rapport presenteras resultat från EU-projektet AGROinLOG (anslagsavtal nr 727921), där fokus har varit att ta fram en färdplan för implementering av IBLC-konceptet (Integrated Biomass Logistic Centres) inom spannmålsindustrin i Skåne. Mer information om den svenska delen i projektet finns i den publika rapporten AGROinLOG (2020).

De svenska parterna i AGROinLOG projektet, RISE och Lantmännen, har haft kontakt med en mängd olika aktörer från spannmålsindustrin i Skåne för att undersöka befintliga hinder och drivkrafter kopplat till utvecklingen av IBLC-konceptet i regionen. I rapporten fokuseras huvudsakligen på kvarnindustrin i Skåne och på potentialen i att utnyttja biprodukten kli och begränsningarna för att implementera IBLC-konceptet. Målet med rapporten är att ta fram en färdplan för omställningen av befintlig kvarnindustri till en IBLC.

Först ges en kort introduktion till IBLC-konceptet och en detaljerad status för spannmåls- och kvarnindustrin i Skåne. Sedan ges en beskrivning av processen för datainsamlingen som inkluderade många interaktioner med industrin och andra relevanta aktörer. Därefter presenteras resultaten.

För att ta fram färdplanen användes en backcasting metodik där en önskad hållbar framtidsvision togs fram som ett första steg. I den framtagna visionen har kvarnindustrin utvecklats till en välfungerande IBLC där ett flertal aktörer samarbetar för att producera ett bredare sortiment av produkter och ett ökat värde har skapats till både kvarnens egna sidosrömmar och till andra aktörers. Denna nya verksamhet är lönsam för kvarnen men även för andra tillverkande industrier. De produkter som tagits fram är högt efterfrågade hos konsumenterna.

Författarna kartlade sedan den aktuella situationen och tittade särskilt på hinder, potentiella intressekonflikter och stödsystem i form av policy. Hindren kan grupperas i sex kategorier: utbud, kommunikation, regelverk, ekonomi, marknad och logistik. Det finns inga stora identifierade intressekonflikter vad gäller användningen av klifraktion eftersom den endast i liten utsträckning används till livsmedel. Det kan dock uppstå konflikter med djurfoderindustrin. Olika typer av stöd behövs i olika skeden av innovationsutvecklingen. Skåne och Sverige i allmänhet har god tillgång till stödsystem. Mer teknisk information om kvarnsektorns nuvarande status ingår i bakgrundskapitlet.

Slutligen diskuteras konkreta åtgärder för att gå från nuvarande situation till visionen. Den viktigaste åtgärden skulle vara att utveckla en marknad för de nya biobaserade produkterna. Ett antal åtgärder bör genomföras i en gemensam insats för att stödja detta. Dessa åtgärder inkluderar teknisk utveckling, samarbete och kommunikation. Dessutom måste hållbarhet vara en röd tråd i denna omvandling, och ny lagstiftning för att ge ett stödjande ramverk.



1 Background

The Swedish partners of the AGROinLOG project have been interacting with different stakeholders from the grain processing industry in Skåne (South of Sweden) to investigate the existing hindrances and drivers for the development of Integrated Biomass Logistic Centres (IBLC) in the region. This report focuses in particular into the milling industry in Skåne in regard to its potential and limitations for the implementation of IBLC. The objective of this report is to propose a roadmap for the transformation of the current milling sector into an IBLC.

1.1 What is an IBLC?

An Integrated Biomass Logistics Centre (IBLC) is defined as a business strategy for agro-industries to take advantage of unexploited synergies in terms of facilities, equipment and staff capabilities, to diversify regular activity both on the input (food and biomass feedstock) and output side (food, biocommodities & intermediate biobased feedstocks) thereby enhancing the strength of agro-industries and increasing the added value delivered by those companies. The name IBLC represents four typical characteristics:

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

For the European agribusiness (primary and processing sector) the opportunity arises to benefit from their position in a sector that has a unique opportunity and potential to develop an infrastructure that enables the supply of biomass feedstock to a new and emerging biobased industry (also including biofuels and bioenergy). For existing agro-industries there are three important drivers to develop an IBLC:

- diversification of inputs;
- optimization of available and new capacity;
- diversification of outputs.

More information about the IBLC concept can be found on the AGROinLOG website: www.agroinlog-h2020.eu.

1.2 Skåne - a county with potential for the development of IBLC within the cereal chain

As part of the AGROinLOG project, the Swedish partners (RISE, Lantmännen, and Processum) are looking at an ethanol plant, Agroetanol, located in Norrköping (in Östergötland county) (AGROinLOG, 2020a). The two following figures show the yearly cereal production per county in Sweden 2017, figure 1, and the location of Lantmännen's cereal reception platforms in Sweden, figure 2. Skåne (South of Sweden) and Västra

Göteborg (West Göta) are the two counties with the largest grain production in Sweden. The yield was in 2017 1,542,900 tonnes and 1,172,000 tonnes respectively (Jorbruksverket, 2018). In figure 2 four clusters can be identified: Skåne, Västra Göta, Östergötland, and the region of Uppsala, Stockholm and Södermanland. There are no major differences in term of relevant regulations between the counties in Sweden.

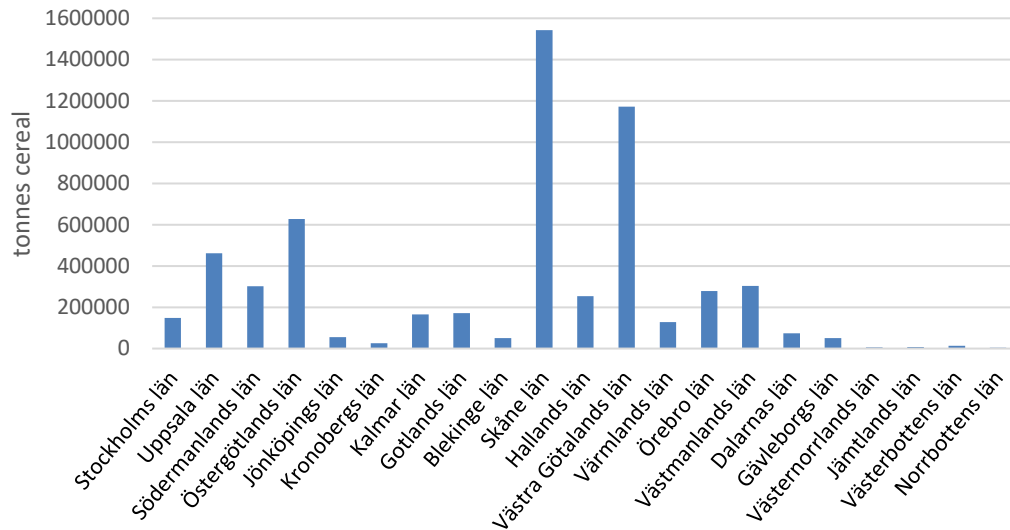


Figure 1. Cereal production in Sweden by region year 2017 in tonnes (Jordbruksverket, 2018)

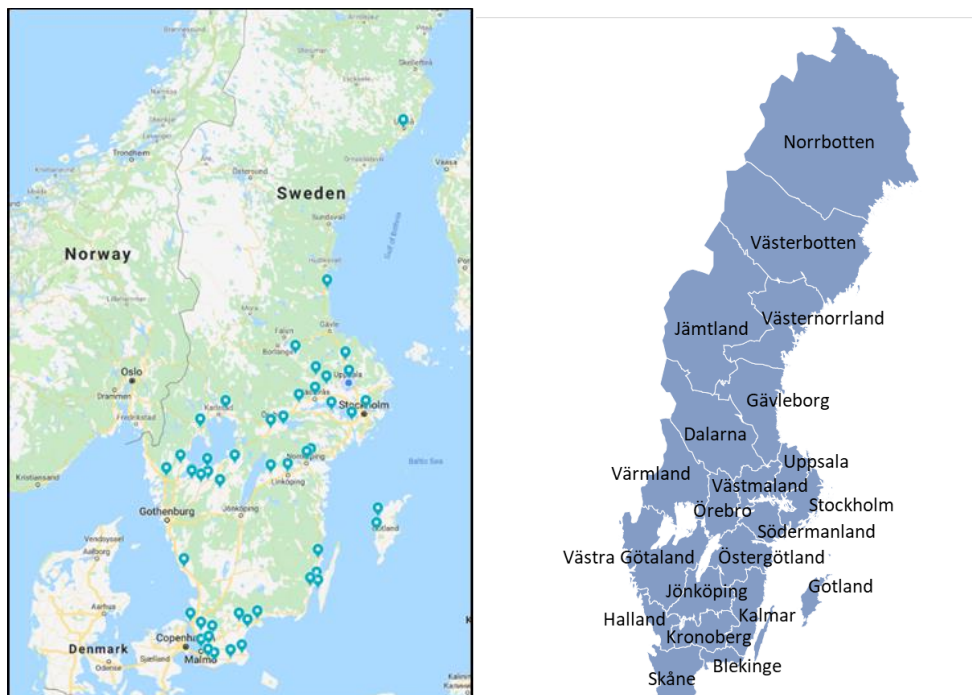


Figure 2. Lantmännen's cereal reception platforms (left) and the Swedish counties (right)

Östergötland was put aside as the Swedish pilot in AGROinLOG already focus on this county. Skåne was selected as it has the biggest cereal production (Figure 1). Moreover, the project already held a workshop concerning IBLC in Skåne in June 2018 where

participants showed interest. Fifteen external stakeholders (industry, public organisations, member organisations and research), see table 1 in Appendix 1, participated in the workshop where hindrances and drivers for the development of IBLC as well as which actors to include in such IBLC. The workshop did not focus on a sector in particular but representatives from the grain value chain were present. Both Lantmännen and RISE have a good network in Skåne. As figure 2 shows, Lantmännen is well established in the county and RISE as well. Skåne also has the ambitious goal to only have fossil free fuels by 2020 making it easier to recruit high level contacts later on when planning the final workshop.

1.3 Meet the milling industry in Skåne

There are several large cereal mills in Skåne, including Nord Mills in Malmö, Farinas kvarn in Lilla Harrie, Abdon Finax in Helsingborg and Skåne-möllan in Tågarp (figure 3 and table 1). Around 1,4 million tonnes of cereals are produced on average in Skåne every year, the share of winter wheat is around 50 %, spring barley 30% and the other cereals between 2-6% each (rye, spring wheat, oat, winter barley and rye wheat). The mills produce a large number of by-products, that could be utilized for more advanced applications than today. One interesting by-product of which there are quite large quantities is wheat bran.

Malmö Stora Valskvarn (Nord Mills/Lantmännen Cerealia) is one of Sweden's largest mills and was started in 1881. The mill processes around 150,000 tonnes cereal yearly and produces about 190,000 tonnes of flour for bakeries, industry and direct sales to consumers. The mill produces around 25,000 tonnes bran per year or 450 tonnes per week. The mill in Malmö has no drying plant so bran is not used as an energy source but is sold as feed after being pelletised for better conservation and transportation. Lantmännen has a business specialised in animal feed to which they sell most of the pellets to. A small portion of the bran, around 75 ton, is processed to be used in food industry. The bran for the food industry is heat treated to avoid hardening of the fat. The sales of the bran to the fodder industry has a strong impact on the business profitability. The mill is built close to the extending city center of Malmö causing problems for their logistics. Recently, the mill cannot receive cereals via boats as its access requires the opening of a bridge which is too costly. This location also implies that the mill is not able to expand its activity. (Lantmännen Cerealia, 2019)

Skåne-möllan started in 1972 and is an alternative to the major flour suppliers, and they focus on innovation. The company has 26 employees and sales are approximately 16,5 million euro/year. Continuous product development is an important part of the work at Skåne-möllan. Skåne-möllan has a cooperation with a biomaterial producing company in Skåne called GAIA Biomaterials. GAIA Biomaterials has invested in a new extruder where flour from Skåne-möllan can be added directly as an ingredient in the production process of the biomaterial. Skåne-möllan processes around 50,000 tonnes cereal yearly of which 10,000 tonnes end up as bran and is sold to the fodder industry. (Skåne-möllan, 2019)



Two other mills are also present in the county. Lilla Harrie valskvarn processes around 65,000 tonnes cereals of which 7,000 tonnes become bran (Lilla Harrie, 2019). Abdon mills processes 50,000 tonnes of wheat, 3,000 tonnes of rye and 8,000 tonnes of oat of which 10,000 tonnes become wheat bran/fodder flour, 900 tonnes rye bran, and 3,200 tonnes oat bran (Abdon Mills, 2019).



Figure 3. Map of Skåne with the four industrial grain mills (1=Malmö Stora valskvarn, 2=Lilla Harrie Valskvarn, 3=Skåne-möllan and 4= Abdon mills)

1.4 Potential for bran as feedstock in an IBLC

Wheat bran is the shell residue that remains when the wheat kernels are ground into flour. The total amount of bran produced per year in Skåne is approximately 56,000 tonnes, table 1 (Lantmännen Cerealia, 2019; Skåne-möllan, 2019; Lilla Harrie, 2019; Abdon Mills, 2019). Corresponding amount of processed cereals is 326,000 tonnes.

Table 1. Volume of cereal processed and produced bran in Skåne.

Mill	Processed cereals, tonnes	Produced bran, tonnes
1 Cerealia Lantmännen	150,000	25,000
2 Lilla Harrie	65,000	7,000
3 Skåne Möllan	50,000	10,000
4 Abdon Mills	61,000	14,000
Total	326,000	56,000

Bran consists largely of cellulose and other water-absorbing carbohydrates. Today it is mainly used as animal feed, and to a certain extent as whole grain products for human consumption or as an energy source for combustion or biogas production. However, there are still bran that could be further processed into new products. There are several different products that can be produced from wheat bran (figure 4). Starch can be extracted and hydrolysed to glucose which can be fermented to chemicals such as lactic acid, succinic acid and ethanol. Lactic acid can be polymerized to PLA (polylactic acid) and succinic acid to PBS (polybutylene succinate). Wheat bran is also rich in bioactive compounds such as phenols, which can be extracted and either sold as they are or used as building blocks for other chemicals such as vanillin.

The left-hand side of Figure 4 illustrates a simplified valorisation chain for the production of flour in Sweden including the current use of the. The right-hand side illustrates the different paths for the higher valorisation of bran. The yellow cells represent biomass or bio-commodities and the green cells final products. Processes for transforming or upgrading the biomass and bio-commodities are not included (except for the milling process). It is important to notice that all final products can be supplied from the same raw material. In other word, if bran is transformed into lactic or succinic acid for the bioplastics market, it cannot be used for energy use, or as solvent. However, if the carbohydrates and non-carbohydrates are effectively separated, the phenols and proteins could be extracted for the food industry for instance.

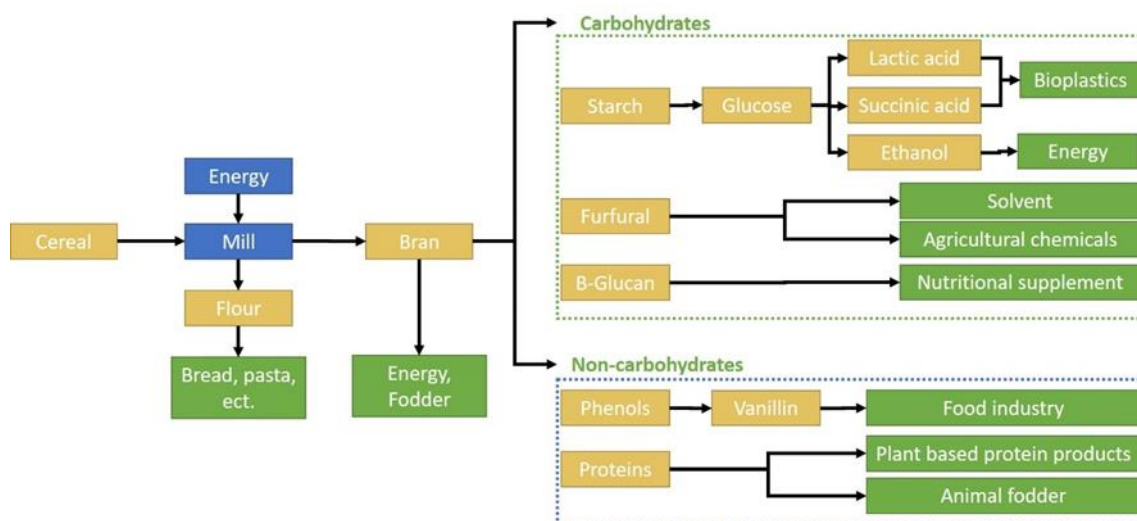


Figure 4. Examples of different production possibilities from bran (SP, 2014)

2 Multi-actor approach

A range of stakeholders have been contacted throughout the project regarding the development of the roadmap. A summary of the different interactions and their purpose is summarised in this chapter.

A first workshop was organised in June 2018 in Skåne. After an introduction to the project and the IBLC concept, the discussion was structured around three main questions: (i) under which conditions would you ideally collaborate in order to establish an IBLC? (ii) what actors should be involved in an IBLC? (iii) what legislative hinders could hamper the development of an IBLC at the moment? In total 19 participants attended the workshop and the different organisations represented are presented in table 1 in Appendix 1.

A year later, nine high-level contacts were contacted (from August to September 2019). Online based meetings, or phone calls were used to perform the interviews. The aim of the interviews was to first introduce briefly the AGROinLOG project and the IBLC concept to set the scene. In order to illustrate the IBLC concept, the Swedish team decided to develop a concrete example taking the bran from flour processing industry as a potential raw material for an IBLC within the grain sector in Skåne. The interviewees were asked different questions concerning the hinders to the development of an IBLC in Skåne but also what could be done to develop such IBLC. The organisations contacted are summarised in table 2 in Appendix 1.

Following the interviews, a multi-actor workshop was organised in January 2020. The aims of the workshop were to present the preliminary results in the form of a roadmap. The roadmap used a backcasting approach, therefore the discussion started dealing with the desired sustainable future of the mills in Skåne. The ABCD-methodology developed by Robèrt et al. (2015) was used as a guideline to structure the workshop and the roadmap. ABCD methodology includes 4 steps: (A) create a common vision of the future in line with the social, economic and environmental sustainability aspects, (B) the current situation and practices are analysed, (C) a list of possible measures to move from B to A is developed, and (D) the measures are prioritised to reach the vision in a structured and efficient way (figure 5). Step D was not considered in this work.

In this first stage of the workshop, the participants attempted to develop a common vision for a future IBLC in the region. Then, the current situation including hinders as well as opportunities based on the interviews was presented and further developed. Finally, participants discussed potential measures to implement to develop the current mills into IBLCs in Skåne, considering the common vision and the current situation. 12 participants attended the workshop and the organisations attending the workshop are summarised in table 3 in Appendix 1.

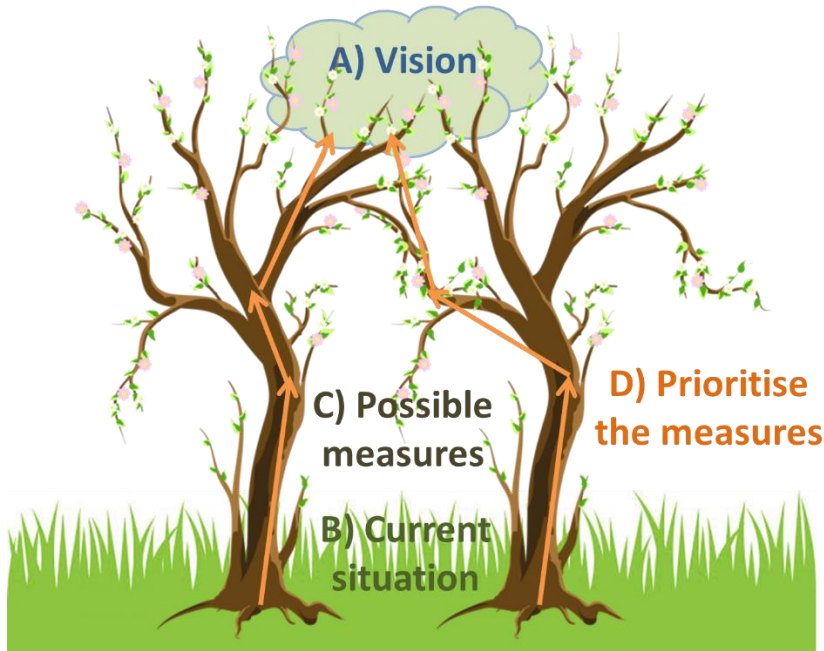


Figure 5. Illustration of the ABCD backcasting methodology

3 Results

The results below reflect the results from both the interviews and workshops described in chapter 2.

3.1 Vision

In 2050, the grain processing industry in Skåne is a fully developed IBLC and play an important role in the bioeconomy. Regional clusters are driving the development supported by public administrations and agencies. Many actors are involved in the clusters and trust each other. Those actors include organisations with knowledge and competence about the processing of by-products, driven entrepreneurs willing to use the by-products, and other mills. Collaboration is both at regional and international level to ensure the sector remains competitive. Start-ups played an important role at the start of the development but were bought by large enterprises once their profitability was proved.

The mills have a wider product portfolio including for instance working with pharmaceutical, textile and the plastic industries but still focussing on the food sector. More bran is used by the food sector through the development of new wholemeal products demanded by a growing health and nutrition conscious consumer base. The IBLC can process different kind of raw material.

Environmental conscious consumers are looking for sustainable alternatives and new markets for bio-based products therefore emerged. The mills also have the capacity to change their production based on the demand. A cost efficient logistic and a

collaboration with other mills are other key aspects explaining the mills profitability with their new activities. There is virtually no interest of conflict with the fodder industry as the processing of the new products also generates by-products used by the fodder industry, and new agricultural practices increases the farms self-sufficiency of nutrients.

3.2 The current situation

Answers from the high-level contacts, and the agro-industries are summarised below. Moreover, inputs from a workshop held in June 2018 in Skåne are also included when relevant. The workshop was dealing with the potential for IBLC in general in Sweden (see chapter 2).

3.2.1 Hinders

Interviewees mentioned a number of factors that could hinder the use of bio-based raw material for industrial processes. The following factors are not listed in order of importance:

- **Supply**

A lot of industries still do not want to take the risk of using bio-based raw material due to both the quality of the raw material but also because of the season dependant aspect of the material. The quality and functionality of bio-based raw material is seen as varying with time which can be problematic to fit industrial processes. Moreover, current systems are often built for standards based on fossil raw material and the transition to new system could induce a cost. The supplied volume of bio-based raw material can vary both within the year and between years which can bring logistic and planning issues. However, looking at the case studied in this report (the use of bran from mills), the supply of bran is relatively constant both between years and throughout the year. Furthermore, due to the trend around bioeconomy and bio-based products, the demand and the competition for bio-based raw materials is most likely to increase.

- **Communication**

As it is today, the lack of communication between suppliers or potential suppliers of bio-based raw materials and the industry could explain the lack of trust concerning the quality of bio-based raw materials. It is also a communication challenge to show that there is enough available raw material to build trust with the industry/customers and encourage them to invest in such solutions. A lack of knowledge concerning actual needed quality was also seen as a hinder for the use of bio-based raw material.

- **Regulation**

Many interviewees mentioned the reviewed Renewable Energy Directive (EU, 2018) and in particular its biofuel sustainability criteria which limit the use of food and feed stuff to produce bioenergy. Moreover, the taxation or the non-taxation of fossil-based products such as plastics hinder the attractiveness of bio-based products. Interviewees suggested that fossil-based products should be taxed as fossil energy carriers like diesel and petrol are. The interviewees could not see either national or regional legislation hindering the

use of bio-based materials. However, it was mentioned that in other countries, some regulations could hinder for instance the production of biogas based on food waste. It is therefore important to have a common approach in the whole Europe concerning regulations and legislations. A workshop participant suggested that the vague definition of waste in the waste framework directive hinders the use of bio-based products coming from by-products. Participants were also critical to the interpretation of ILUC (Indirect Land Use Change) on the EU level. ILUC should be interpreted on a local/regional level looking at the resources available and not follow a “one size fits all” regulation.

- **Economy**

To bring some positivity in this chapter dealing with hinders, it is interesting to mention that the economic hinder was not always mentioned and not always the first one mentioned. Bio-based raw material of similar quality as its fossil substitute are often more expensive and have a higher added value for instance if they are climate-neutral. Depending on the final product, it is hard to transfer this higher value on the final price. It is therefore essential to find the right business model, and the cooperative system could be interesting to share the profit to the farmers. The high investment cost to start a biorefinery or updating the current system to adjust to bio-based material is also an economic hinder. This combined to the price fluctuation due to the seasonality and the dynamics of the market where different actors compete for the same raw material could explain the reluctance of investors. An interviewee mentioned that using bio-based raw material can increase considerably the cost to purify and clean the raw material to produce pure chemicals. In general, it is still a major issue today to get a cost-efficient industrial production with bio-based raw products. According to the discussions on the workshop, the mills have a good relationship with the feed industry as they pay a fair price for the bran. This aspect should be included to the economic calculations, as bran is not a by-product with no value at the moment.

- **Market**

The market for bio-based products are maybe still underdeveloped and more focus should be given to it. The example of biogas, where the market often includes only one local client (public transport) showed some vulnerability on the long term. It is therefore important to find a market with a wider range of end users to reduce the risk. To develop a market, it is essential to identify the customer and some interviewees showed some apprehensions about this issue. The question being if it is private persons, companies or a whole sector. The answer depends on the final product but certainly include different actors, making the marketing to the end user difficult. A key factor is to find a market willing to pay for bio-based premium, and the consumers’ limited knowledge does not promote the development of such market. Example of potential markets with such opportunities are the food industry and the personal health sector. The interviewed industries showed interests for the biomaterial sector (production of bio-commodity for the plastic industry) and the food industry (plant-based protein products). Looking at bioplastics, there are still a lack of bio-based alternatives limiting its market.

- Logistics

To transport bio-based raw material like grass, straw, or bran often means great volumes of low value products. It is therefore important to keep the transport as short as possible and find the customer close to the production site. As there are no constant flow of material, its logistic must be really flexible. For agricultural-based raw material there are many suppliers (often farmers) delivering to a single actor. This induce that one side of the chain has to be flexible and this should be considered early on the development on the value chain. Industries are not used to work with flexible supply of raw material, and this is therefore a dilemma for them (Workshop, 2018). However, when focussing on bran, the raw material is already gathered at the different mill plants and its supply relatively constant. As bran is a fresh material, it should be transported and processed quickly to avoid the loss of valuable elements. Moreover, the bran must be processed relatively close to the mill to keep the cost down. Some interviewees also raised the sustainability aspect of the logistic as it important to return the nutrients back to the cultivation and use resources locally.

3.2.2 Conflict of interest

In general interviewees were positive towards new utilizations of the bran as it is a by-product and only used in small amounts for human consumption today. Some highlighted that further studies should show what would be the most effective use in term of environmental impacts.

At the moment bran is mainly used in the feed and fodder industry, and according to some interviewees, there is a lack of bran for this industry. Therefore, there could be a conflict of interest if the feedstock substituting bran would have worst environmental impacts for instance. Moreover, this could lead to an increase in the feed and fodder cost.

On the other hand, bran contains vitamins and minerals needed for human consumption and giving it instead to animals can be seen as a conflict of interest. Therefore, if the minerals and vitamins could be retrieved for human consumption this could be an improvement.

3.2.3 Policy support

Effective supportive policies and measures depend on the development stage of the sector and market. In the first place, if needed, research and development should be supported to bring new and effective solutions and processes. Before investing in a production line, it is important to find a functioning business model generating profit. Vinnova (Swedish Innovation Agency, 2020) and Energimyndigheten (Swedish Energy Agency, 2020) offer such support. Vinnova, Energimyndigheten, and Formas (Swedish government research council for sustainable development) finance the strategic innovation program BioInnovation (2020) aiming *“to create the best conditions for the development of the Swedish biobased sector, and to create sustainable solutions for a global market”*. Supporting incubators is also needed in order to test a product on a new market for instance. The final step to develop a new branch is to get an industry to invest.

Very often, the first company to invest in a new branch or market need larger investments than its following competitors that could create a still situation where nobody dare to invest first and take the risk. Therefore, investment support is needed to encourage industries to invest on new production for instance. It seems that Sweden offers good support opportunities for the development of IBLCs at the moment. However, it is difficult to set conclusions on the availability of those supports in the future as calls and strategies can change between years.

In Skåne, the Regional board of Skåne offers different type of support around circular economy and bioeconomy. Interviewees believed that there are other relevant support schemes at EU and national level. Skåne has a long experience of innovation within the food chain sector which could be shared when relevant.

At the moment, the renewable energy sector has a good access to support in Skåne. Skåne has developed a roadmap for biogas with supporting measures to reach their goals. Other support is also available for other types of renewable energy, for instance green biofuels. A general comment was that in general there are more support for bio-based energies than for bio-based materials and products.

Comparing with the energy sector and energy use in general, industries do not have incitements to use or produce bio-based materials in regard to the regulation and taxation. Policies should promote the use of bio-based products when feasible instead of using fossil-based products. The potential implementation of climate tolls (Carbon Boarder Adjustment system) in EU could be positive for the bio-based material sector. More information should be shared in line with EU “Green deal” during 2020 and 2021, including for instance a Circular Economy Action Plan with a sustainable products initiative were plastics are seen as one key product (EU, 2019). Some interviewees believed that the situation within the plastic sector is moving quickly regarding the use of bio-based raw material and supportive measures should follow the trend with some delay.

In general, interviewees thought it is important that supportive policies and measures apply on a long-term timeframe to facilitate long term investments. Moreover, supports should be aligned at the EU level. Moreover, it was mentioned that smaller enterprises can be scared of the administration and bureaucracy often associated to the support schemes.

Finally, some interviewees warned about the subsidisation of sectors as it is not sustainable according to them, at least on the economic perspective. The product should be viable on the market without subsidy on the long term.

3.3 The keys to development

To facilitate the development of the current milling industry in Skåne and guide it to the desired vision established above, many elements and measures should be considered. To ensure an efficient process with maximum impact, the proposed measures should be implemented in a joint manner. The following paragraphs consist of a non-exhaustive

list of measures. Some measures are specific to the milling industry in Skåne while others are related to the implementation of IBLC in general, but still relevant for the milling industry in Skåne.

- Develop a market or most probably several markets in parallel, to find highly demanded products with high added value. A first concrete measure is to compare the market price with the production cost to find the products with the most potential for profitability. Products that showed interest are biomaterials, bio-based chemicals, second generation biofuels and food. More concrete examples of product development include the development of different quality of bioplastics, from simple layer to more advanced protection for sensitive food stuff, matching the needed requirements. Another example is the development of cured meat products including fibres from bran. A change of mindset shifting business models from product development to solution delivery could benefit the market development. A general comment would be to not only restrict to local markets. All following measures and aspects are relevant to the market development and should be implemented having the market development and profitability as an objective.
- Pursue the technical development to supply state-of-art technologies aiming to reduce costs. For instance, the development could focus on yield increasing, energy efficiency of the process and logistic, and opportunity for transregional upscaling. Moreover, the integration of different by-products in the process should be further investigated, considering their seasonality. The possibility to work with flexible process in term of outputs too, offering different end products should be studied.
- Collaborate to build IBLC consortia to facilitate the implementation of IBLC in the region/country. It has been explicitly said during the workshop what the mills will not drive the development process of the operation of by-product processing. It is therefore important to have a driven partner engaging with relevant stakeholders within the whole value chain. Companies should be involved early on in the discussion to ensure that the profitability aspect is on the table. Such open innovation platforms are therefore needed where actors from different sectors can meet. Other actors such as raw material producers, the industry, politicians, by-products users, logistics partners and consumers when relevant should be part of the development phase too. Some good practices from the forest industry could be used as inspiration, for instance regarding logistics.
- Communicate to build trust between actors and with the end-user/consumer and increase added value on the final product. More hard figures should be used to reflect upon the impact, for instance using Life Cycle Assessments methodology. It is important to target the communication to the right stakeholders and not necessarily to a mass audience. However, consumers should be informed to be able to take the right conscious choice while consuming. Informing younger generations based on fact could increase the demand of bio-based products in the



long term. Mastering the storytelling throughout the whole value chain would secure an increased added value to the final product.

- Think sustainability to ensure a viable, durable and holistic solutions. By definition fossil resources are finite and limited and therefore not sustainable on a long-term perspective. Fossil free alternatives should be sustainable on the three different dimensions of sustainability (environment, social and economic) to avoid the creation of new problems. Moreover, when dealing with bio-based raw material it is essential to consider the recirculation of nutrients to the primary sector.
- Ensure a supportive legislation to enable innovative and sustainable solutions to develop and thrive. New and coming bio-based products such as biochar still lack standards and rules which should be developed. The development of new legislation should reflect the indications from research. New regulations and legislations should be long term to encourage investments. Dialogue should remain open between public authorities and other stakeholders (see the “Collaborate” paragraph).

More general aspects to consider when implementing an IBLC within the grain sector can be found in the Best Practice Guidelines developed by the AGROinLOG project for the grain processing sector (AGROinLOG, 2020b).

4 Conclusions

The grain mills in Skåne have a great potential to develop into IBLCs. The supply of bran is relatively constant other the year which is an advantage for industrial processes. Moreover, as bran is produced centrally in four different mills, the logistics would be rather simple, even if one or more plants further process the bran fraction. The mills were not interested to be further process the bran fraction themselves as it would require new competences and skill, but also large investments. Therefore, a new actor is needed to drive the development process as well as the processing of bran. Moreover, it is not yet determined which process should be used and which product should be delivered. Different markets are of interest: biomaterials, bio-based chemicals, biofuels and food. In parallel with the design of the bran processing, further research on the availability of other regional by-products to include to the process should be carried out.

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Appendix 1.

Table 1. Organisations represented during the Workshop in June 2018.

Organisation (in Swedish)	Organisation (in English)	Type of organisation
Cerealia	Cerealia	Industry
SLU	Swedish University of Agricultural Sciences	University
RISE	Research Institutes of Sweden	Research Institute
AESA	AESA	Agri consultant
Lantmännen	Lantmännen	Industry, Cooperative
Region Skåne	Regional board of Skåne	Regional administration
Nordic Sugar	Nordic Sugar	Industry
LRF	Federation of Swedish Farmers	Farmer Organisation
Gasum	Gasum	Industry
Perstorp	Perstorp	Industry
Hållbarhetsstrateg	Sustainability Strategist	Sustainability consultant
Energikontoret Skåne	Energy agency of Skåne	Regional administration
Jordberga gård	Jordberga farm	Farmer
GAIA Biomaterials	GAIA Biomaterials	Industry
Absolut Vodka	Absolut Vodka	Industry

Table 2. High level contacts interviewed.

Organisation (in Swedish)	Organisation (in English)	Type of organisation
Cerealia	Cerealia	Mill
Skåne-Möllan	Skåne-Möllan	Mill
Energimyndighet	Swedish Energy Agency	Public agency
Foder och spannmål	Fodder and cereal	Member organisation
Lunds Kommun	Municipality of Lund	Municipality
Region Skåne	Regional board of Skåne	Public administration
IKEM	Innovation and Chemical Industries in Sweden	Member organisation
Spannmålsodlarna	Cereal farmers	Member organisation
LRF	Federation of Swedish Farmers	Member organisation

Table 3. List of participating organisations at the workshop in January 2020

Organisation (in Swedish)	Organisation (in English)	Type of organisation
RISE	Research Institutes of Sweden	Research Institute
Cerealia	Cerealia	Mill
LRF	Federation of Swedish Farmers	Farmer organisation
Lilla Harrie Valskvarn AB	Lilla Harrie Mill	Mill
Packbridge	Packbridge	Industry
Sweco Energy AB	Sweco Energy AB	Engineering consultant
SLU	Swedish University of Agricultural Sciences	University



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I internationell samverkan med akademi, näringsliv och offentlig sektor bidrar vi till ett konkurrenskraftigt näringsliv och ett hållbart samhälle. RISE 2 800 medarbetare driver och stöder alla typer av innovationsprocesser. Vi erbjuder ett 100-tal test- och demonstrationsmiljöer för framtidssäkra produkter, tekniker och tjänster. RISE Research Institutes of Sweden ägs av svenska staten.



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