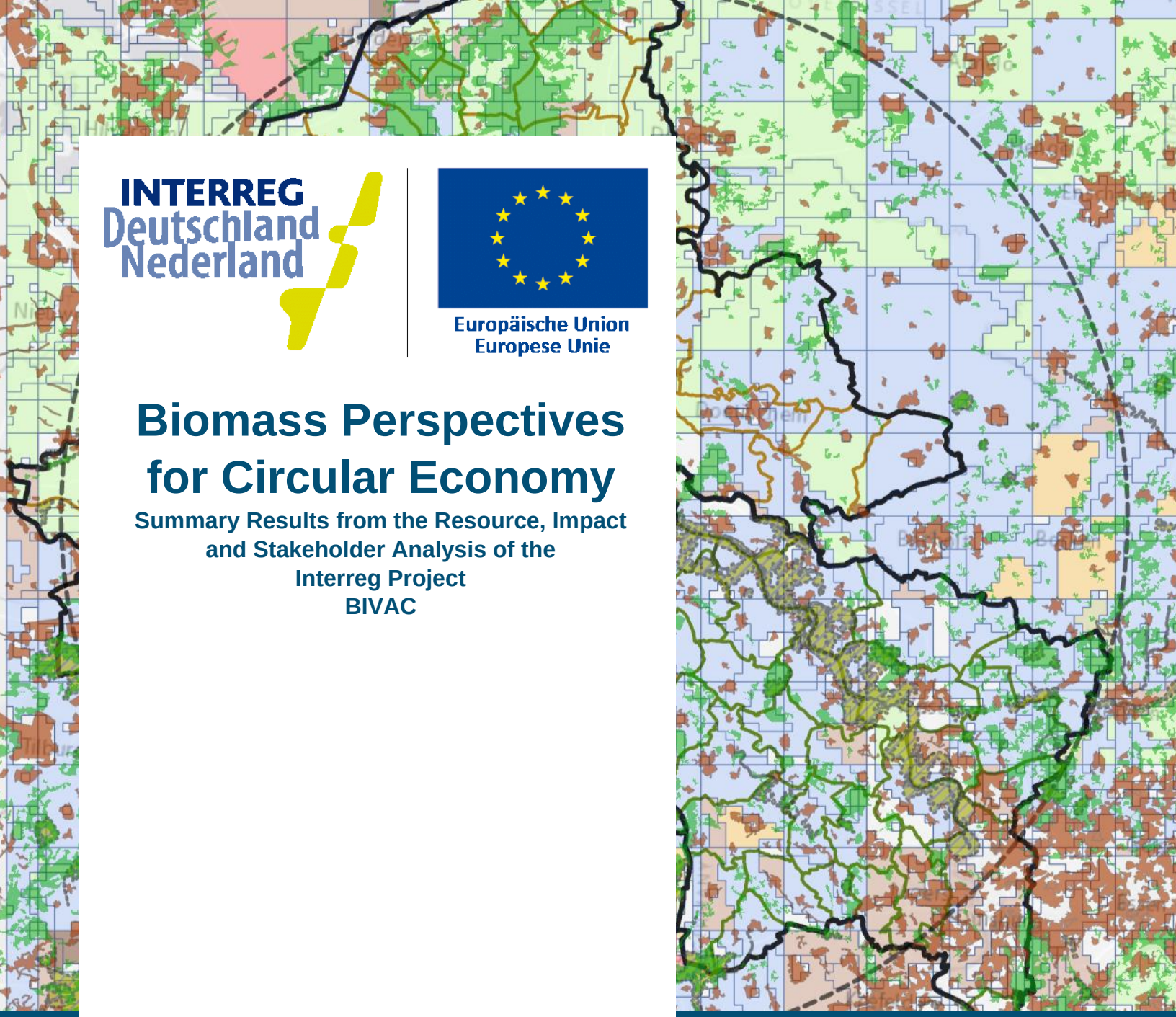

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Biomass Perspectives for Circular Economy

Summary Results from the Resource, Impact and Stakeholder Analysis of the Interreg Project BIVAC

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BIVAC

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The Interreg Project BIVAC

The overall goal of the Interreg Project BIVAC has been to explore cross-border opportunities between the Netherlands and Germany for exploiting biomass streams resulting from agricultural and horticultural practice and subsequent food processing at industrial scale. These biomass streams can be valorised by upcycling, thereby contributing towards reducing greenhouse gases (especially CO_2) while supporting a wider set of further sustainability assets. During the three years of project implementation, BIVAC has demonstrated technical and organisational procedures for using a variety of biomass streams such as grass, leek, onions, sugar beet, peas from agriculture as well as spruce and popular residues from forestry as input for fermentation processes to arrive at high value products. For example, protein concentrates for animal feed as well human food, substituting traditional protein sources such as soy, maize and wheat to the benefit of the environment. Other business cases include food additives, cosmetic and pharmaceutical products such as onion-flavoured proteins, a pure raspberry flavour (chiral scent (R)-α-Ionone and the superfood and fish-feed additive astaxanthine.

The Region

On the Dutch side, the agrifood cluster consists of companies involved in the whole food chain from production towards consumer - including bioproducts and green energy. With more than 55,000 people - one sixth of all jobs – working in food production, the agrifood cluster is a key economic driver of Northeast Brabant. These people work at a total of about 7200 companies, about two thirds of them in the primary sector and one-third in the secondary sector. On the Dutch side, we find Northeast Brabant, considered the AgriFood-Capital (AgriFood Capital, 2018), bordering the region of Arnhem/Nijmegen, supported by knowledge centers such as Brainport Eindhoven and Greenport Venlo. In this region, there are strong links between the Netherlands and Germany, especially between Venlo and Niederrhein-region, but also between Rotterdam (harbour) and the Ruhrgebied of North Rhine-Westphalia. This acts as a logistic bridge towards central-Europe, providing important context and synergy potentials. On the German side, there is a much higher density of greenhouse cultures and specialised horticultural special productions. At the

Map 1 : Project area in cross-border Region Rhine-Waal / Rhine-Maas-North

same time, there are fewer agrifood hubs – at least not of the same type as in the Brabant-Limburg region. The closeness to Düsseldorf with more than 650.000 inhabitants offers a substantial consumer landscape. The trends regarding livestock farming (intensification) are comparable to the Dutch side – but at clearly lower levels.

The Findings

Resource analysis: using a set of cross-boundary statistics on agricultural production and the associated residue streams derived from international data[1], it has been possible to map biomass streams relevant for high value, innovative products in the ERW. Nine crops have been included in this analysis, including sugar beet, leek, peas, beans, rhubarb, white carrot, onions, white and red cabbage. Next to the overview on all 7 biomass streams, we offer an in-depth 'spotlight-view' on three selected crops, namely grass, sugar beet and aggregated vegetable data with detailed interpretations of 2019 data. Using high-resolution data (AAN/FSU)[2], we examined distributional patterns and opportunities for upcycling.

Impact Assessment: we conducted a deep-dive analysis for the identified 3 'spotlight' crops: sugar beet, vegetables and grass. Building upon an adaptation of the Driver-Pressure-State-Impact Response Framework (European Environment Agency) and the methodological framework of the EU project REPAiR on biomass flows, we assessed biomass flows indicators such as amounts, structure, efficiency. Using these indicators, a semi-automated Flow Projection Model has been developed for the three spotlight crops. The model predominantly focuses on input flows from production areas to hubs, developing a series of flow maps with flow directions and volumes using 2019 data. For each of these streams we interpreted the results according to the three sustainability pillars: environment, social and economic impact.

The Stakeholders

Using the partners and candidate hubs that have been recognised as key to the transition process towards a circular economy as a basis, we mapped the existing stakeholder network according to the level of influence and interest each stakeholder has in the biomass sector. This mapping indicates the level of biomass volume capacity as well as the stakeholder influence in relationship to the innovation pyramid, highlighting the role of other relevant activities and identified gaps in the emerging network. In particular, we propose two mechanisms that can support improved cooperation and integration of the biomass sector: Communities of Practice and Over-The-Fence Partnerships.

[1] Corine Land Cover data 2020 and FSU-food (Farm Structure Units) CAPRI crop data provided by the JRC in 2020.
[2] AAN: Agrarisch Areaal Nederland: high- resolution geographical definition of agricultural land at the level of land parcels. Available at: https://www.pdok.nl/introductie/-/article/agrarisch-areaal-nederland-aan-

Biomass Resource Analysis

This analysis makes use of the most recent geo-referenced datasets for both the German and the Dutch region of the study area. The data collection at the national and international level actually allows biomass assessments for a large variety of crops, such as different varieties of wheat and maize, or, for example, just on tomatoes. We focused mainly on those crops which are of special interest for the participating partners and their value chains. Of special interest has been the central region of the Euregio Rhine-Waal as determined by the locations of Biomassplein Boxtel in North-Brabant in the East, Cargill-Krefeld in the West and the business park Zevenellen in the South. In the following we elaborate the results of the Biomass Analysis for three main so-called 'spotlight' crops, namely vegetables (8 types), sugar beet, and grass. For these 'spotlight'-biomass streams we offer more in-depth assessments with regard to locations, availability (hectares and dry matter volumes) as well as specifications related to the participating companies' processing operations. Detailed assessments of the eight single vegetable residues (leek, peas, beans, rhubarb, white carrot, onions, white and red cabbage) can be found in the full report.

Vegetables

Map 2 has been generated by using the aggregated vegetable layer of the FSU data set. Please note that this does not include data on tomatoes. Of course, the total list of vegetables which has been considered in this aggregation is much longer than the eight target biomass types presented in the full report and does provide an interesting aggregation on vegetable biomass streams that is of interest for the participating companies Biorefinery Solutions (BRS) and Grassa. Though the companies focused especially on the eight vegetable types that have been analysed in more depth, this aggregated view points at further potentials for new high value chains. Figure 1 illustrates the data for extracting protein from different vegetable residue streams, pointing at large potentials at the level of national and regional production.

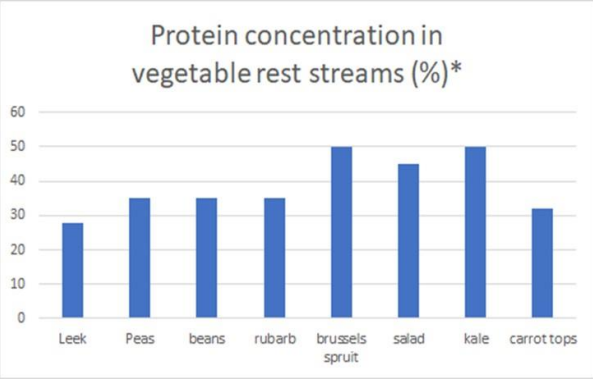
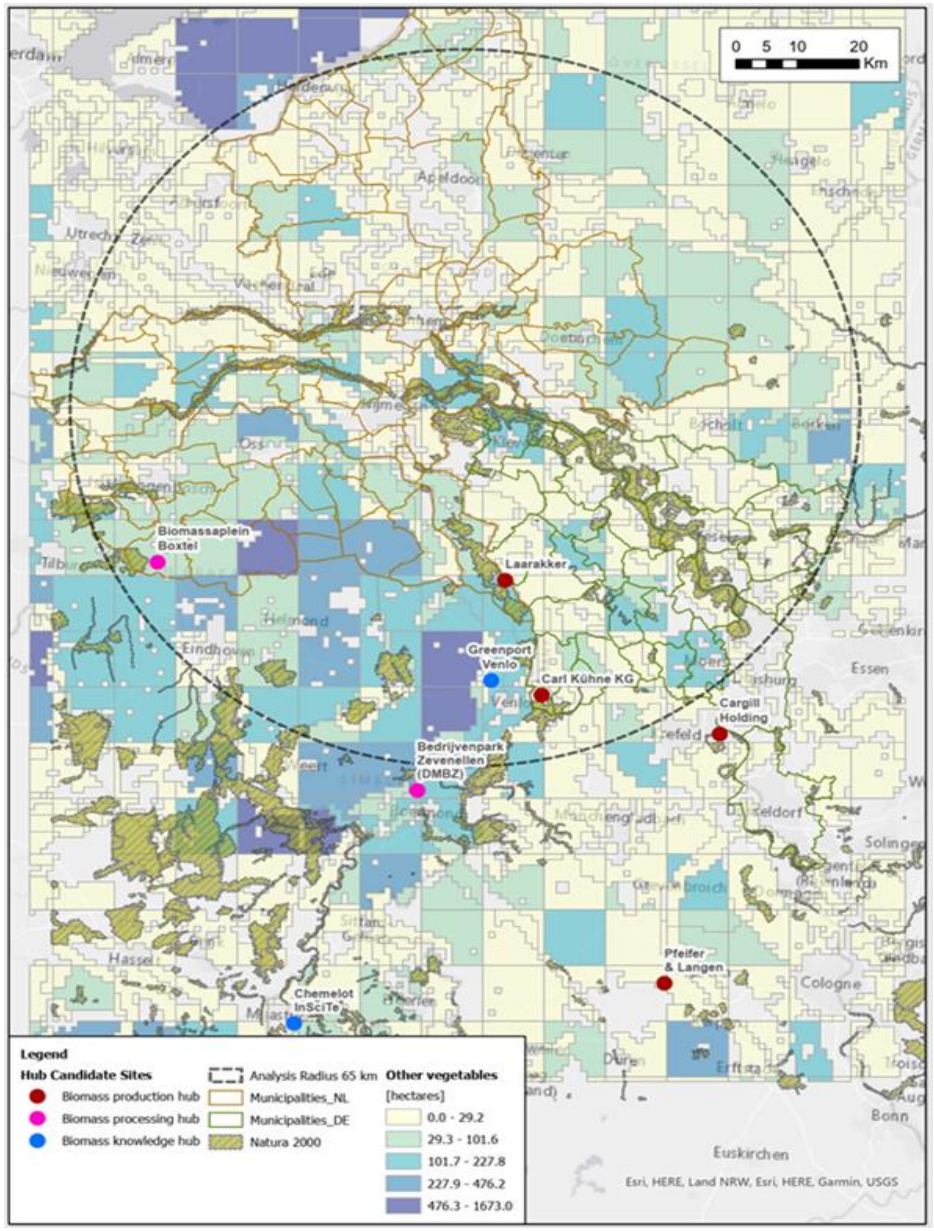
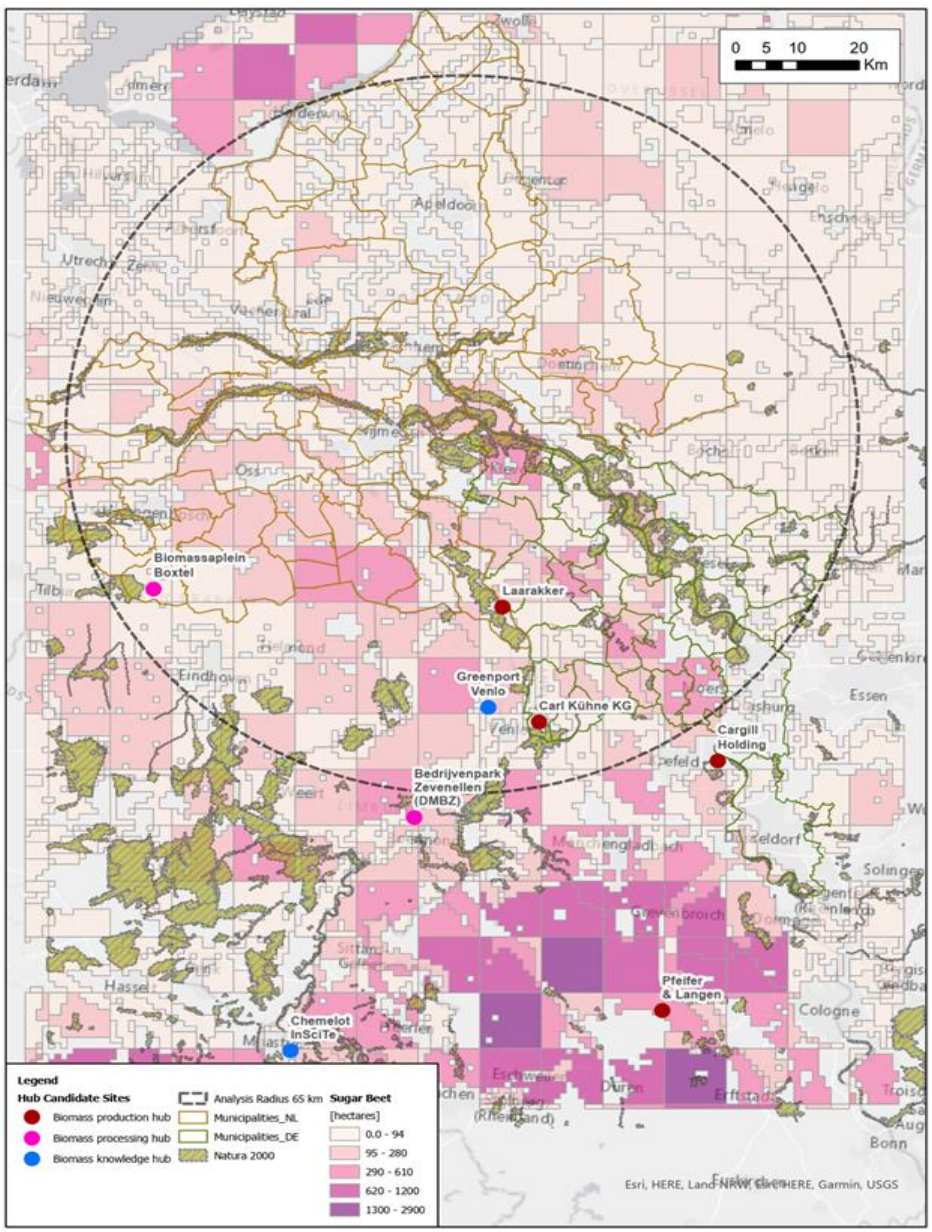


Figure 1 Protein concentration of vegetable residue streams in percentage: * after concentration (Grassa 2020)



Map 2 Mixed vegetables (without tomatoes) according to European FSU data

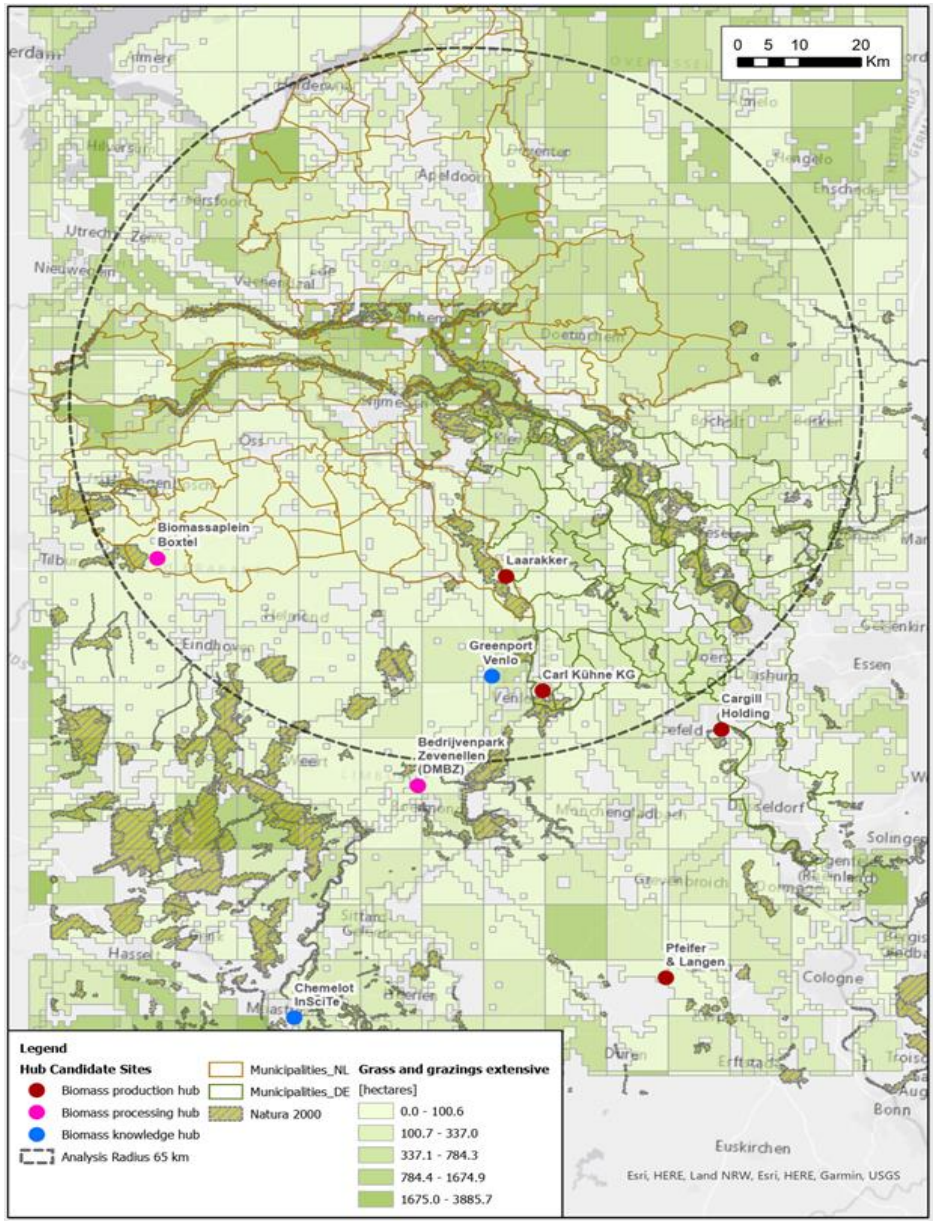


Map 3 Sugar beet production according to European FSU data

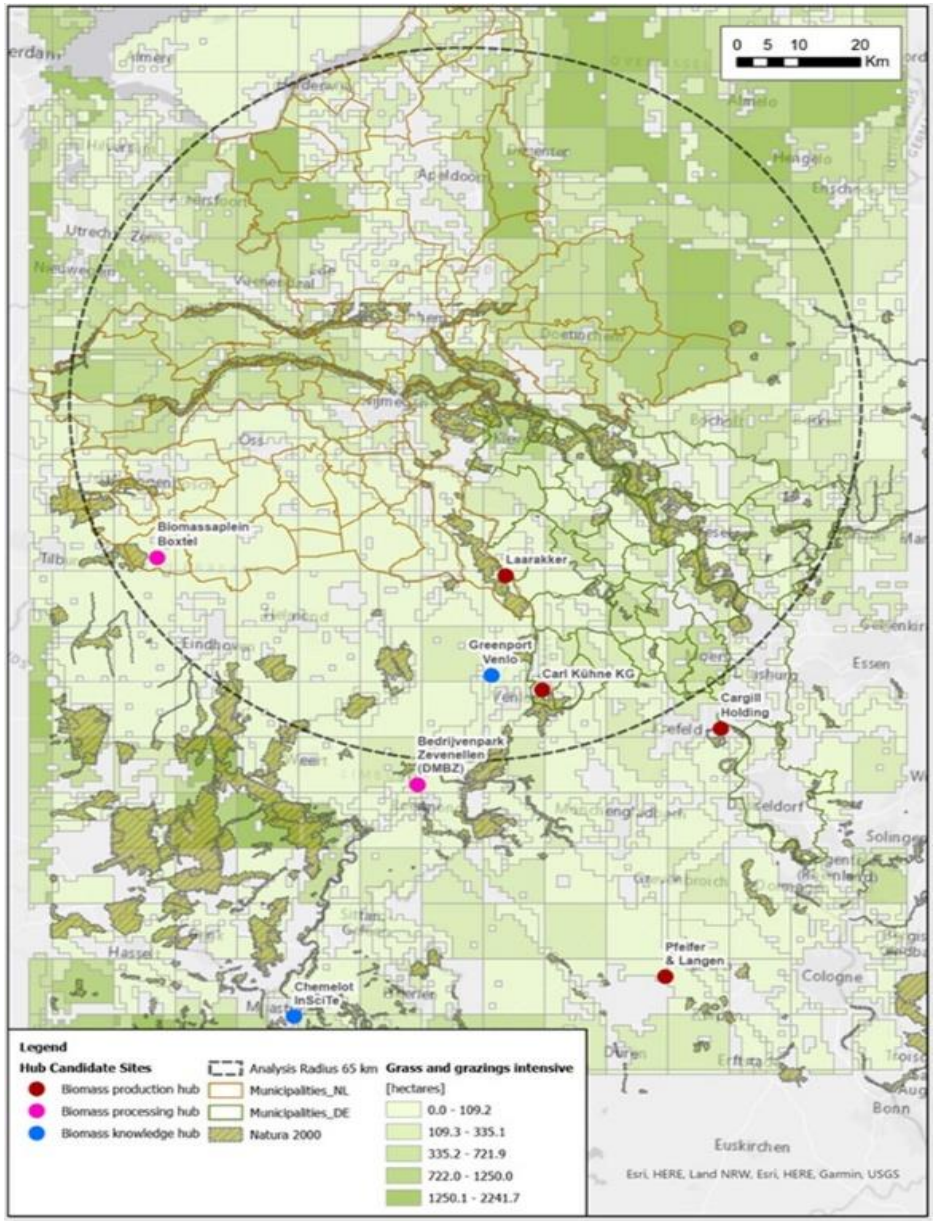
Grass

Map 4 and Map 5 show rather similar distribution patterns for both extensive and intensive grasslands. Naturally, extensive grasslands are more often located in low land corridors and in and around protected areas. It is hence advisable to explore nature management authorities with regard to accessing grass biomass after harvest. Especially from a biodiversity point of view, it has the advantage of reducing excess nutrients in natural ecosystems because of the high-level of nitrogen input via air and water systems.

The use of grass as a biomass stream is oriented towards grassland management systems which generate surplus which becomes accessible for other purposes. Depending on the type of management, we must differentiate a wide range of grassland types with natural, non-managed grasslands which can only exist under certain climatic and geomorphological conditions (e.g. steppic grasslands in the Russian tundra or high elevation dray grasslands on marginal ranges) on the one hand, and high, intensity farming grasslands on rich lowland soils and/or frequently fertilized agricultural lands on the other. Fresh or ensiled grass is one of the main components for diets in livestock farming. In order to increase the productivity of the grassland and its value as feed, they are often of low diversity (e.g. lolium perenne monocultures), are heavily fertilized with nitrogen and of low value for biodiversity. Because of the high growth rate of such grasslands, grass can be harvested early offering a high proportion of easily digestible cellulose and high protein content. Typically, such grasslands are fully integrated in the livestock management and hardly available for non-farming purposes. By contrast, semi-natural or extensively managed grasslands are characterised by high species diversity, low nitrogen levels and low grazing and or harvesting activities, suggesting that residues may be available for uptake in the bioeconomy.



Map 4 Grass and extensive grazing areas according to European FSU data



Map 5 Grass and intensive grazing areas according to European FSU data

Impact Assessment

To assess the impact of using biomass streams in the ERW, we identified a range of indicators applied in flow projection modelling. Flow projection modelling is a GIS-based approach towards analysing waste and resource streams in the context of territories and groups of actors. Based on these flow streams, we can visualise how the bioeconomy could look, and therefore the sustainability impact. The flow indicators identified in the REPAiR project (REPAiR, 2019) have been:

- Flow amounts (for each material or their combination, e.g., vegetal waste vs. separate vegetables and fruits),
- Flow structure (e.g., percentage of renewable material in each flow),
- Flow efficiency (relationship between economic factors and each material flow), and

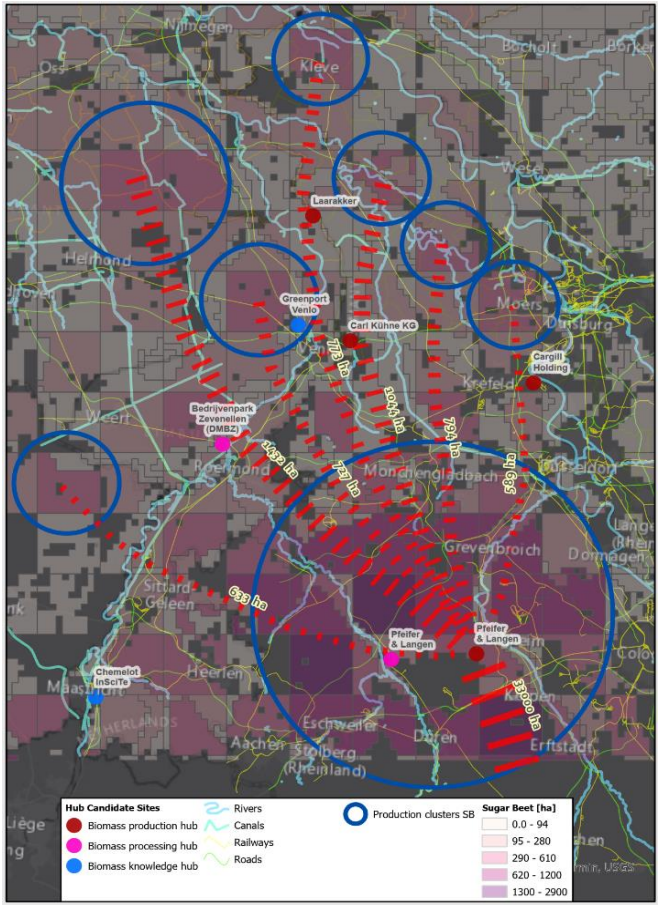
Given the moderate scope of this project, we decided to make use of available European and national data addressing some of the impact dimensions of sustainable food systems. Some of the key parameters are derived from Life Cycle Analysis (LCA), market research and company-specific indicators. Also here we focus on the three spotlight biomass streams which we examined earlier, namely), vegetables (Map 6), sugar beet (Map 7) and extensive grasslands (Map 8).

Vegetables

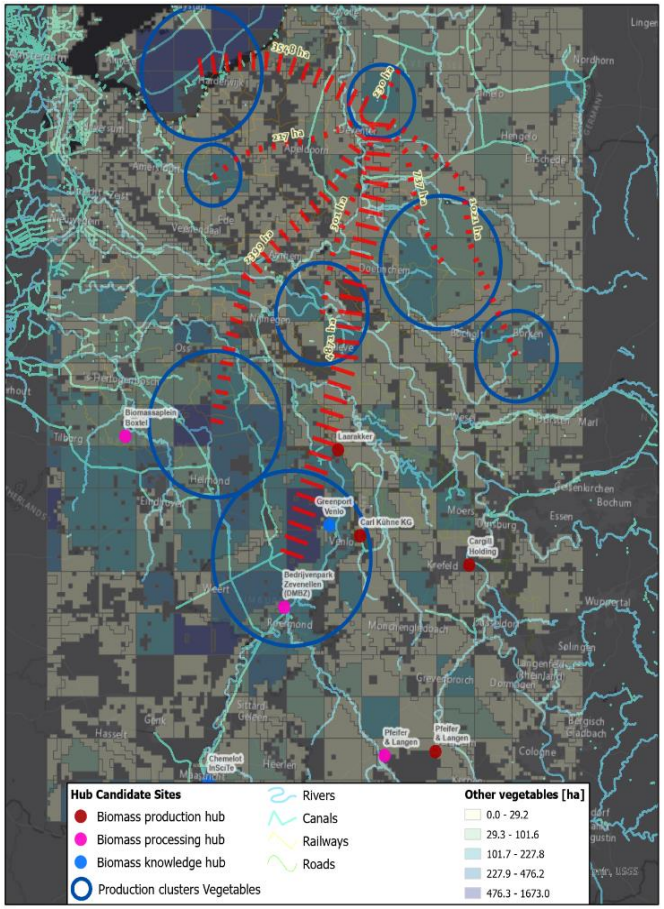
For biomass streams from vegetables, we analysed the trajectories towards the location of company BRS in Raalte North of Deventer, thus just outside the Euregio Rhine-Maas. While being located at the centre of a high production area (230 ha), the region offering the highest amount of biomass is actually located in the Flevopolder (about 3500 ha), followed by locations near Doetinchem, Ede, Nijmegen and Borken. It should, however, be noted that in the coming upscaling strategy of BRS, it is most likely that their activities will be located in North Limburg to make use of knowledge, partners and biomass streams already established in this area. It is therefore likely that flow projections will be largely centralised around Venlo.

Sugar Beet

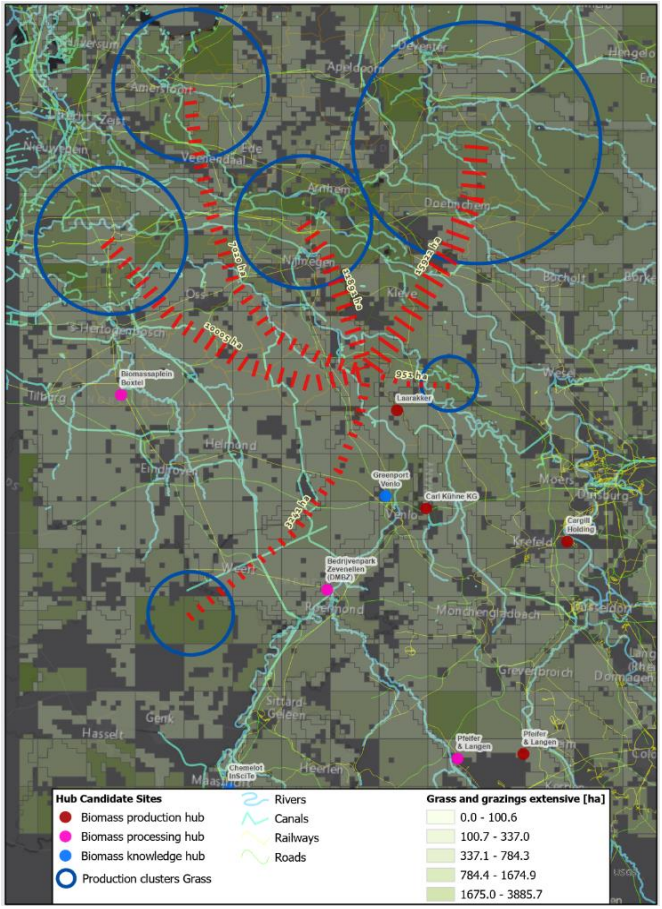
For sugar beet we have chosen the company Pfeiffer & Langen as the central operational location with the storage capacity, sugar refinery and logistic hub. Map 6 shows the proximity of the high production to the locations in Elsdorf and Jülich. Currently, this region is providing sufficient volumes for the company's production (as of 2021). The other production hot spots are the regions South of Werth, North of Helmond, West of Venlo, Kleve and three sites along the German border.



Map 6 Flow projections for vegetable biomass streams with company BRS as central operator (in Raalte, The Netherlands)



Map 7 Flow projections for sugar beet production with company Pfeiffer & Langen as central operator (Elsdorf/Jülich, Germany)



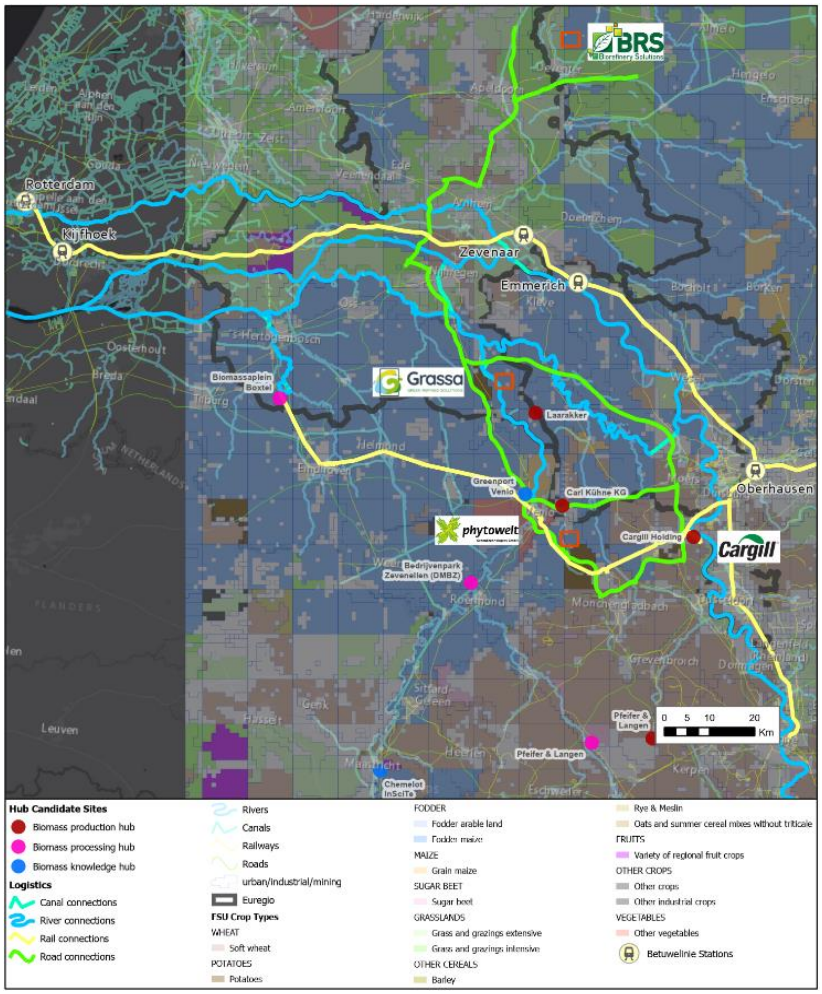
Map 8 Flow projections for extensive grass biomass streams with company Grassa as central operator (in Afferden, The Netherlands)

Grassa

Projections for grass biomass residues have been centered around Grassa's production location in Afferden, where biomass can be aggregated and processed. Surrounding this location, there are numerous grass biomass production areas within reach. For the purpose of the flow projections, extensive grazing areas have been selected as a biomass source, rather than intensive grazing areas which are likely to already be fully exploited.

Developing a Community of Practice

As displayed in Map 9, the Euregion Rhine Waal has a promising number of highly relevant actors and stakeholders linked to the biomass sector, many of whom have already been active in the BIVAC project itself. These stakeholders will play diverse roles in the development of the biomass sector in the region, including biomass producers, food and biomass processors, technology suppliers, transporters and knowledge providers. The observed fragmentation is not necessarily reflecting the perception of the involved players since these are engaged in multiple business networks of their own. However, from the perspective of a circular economy approach, it appears that a range of potential biomass streams are not yet part of a wider network and that obvious synergy opportunities are far from being recognised. Overcoming this fragmentation can be pursued by establishing a so-called *Community of Experts* network (Wenger 1999) , consisting of a wide range of stakeholders that share an interest in regional bio-economy, or by other models such as '*over-the-fence'-partnerships* between key partners of a common business interest. Obviously, both models can co-exist and can evolve from each other.



Map 4 Logistics of the Euregio Rhine-Waal in context of hubs and BIVAC partners

Stakeholder mapping also allows us to comment on the relationship between Market Closeness and Influence that can assist us in the development of relevant strategies pertaining to the engagement and inclusion of stakeholders in sector activities . Mapping categories can be described as follows:

1) **Low Market Closeness x Low Influence** - these stakeholders should be monitored, though direct engagement is not necessary.

2) **Low Market Closeness x High Influence** - these stakeholders are necessary for the success of the sector, though their intrinsic interest may be limited. Therefore, it is essential to keep these stakeholders satisfied to ensure their participation in the sector.
3) **High Market Closeness x Low Influence** - these stakeholders are highly relevant to the sector, though their sphere of influence is limited. In this case it is essential to keep these stakeholders well informed regarding sector developments, maintaining engagement and building relationships in the case that their influence increases and more impact can be achieved.
4) **High Market Closeness x High Influence** - these stakeholders can be considered 'key players' in the sector, and may be providing essential resources for the sector's success. Relationships with these stakeholders should be managed closely.

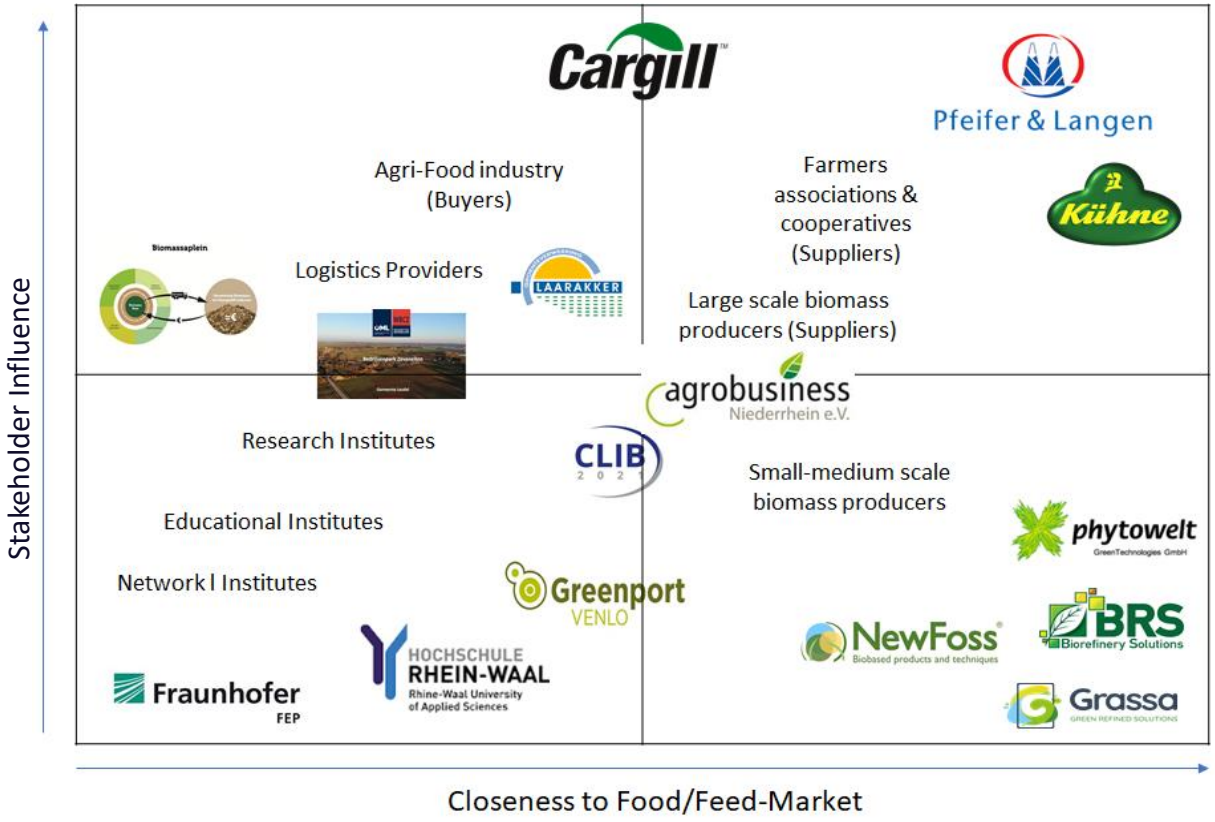


Figure 2 Assessment of stakeholder according to influence vs. Market Closeness

Transition Pathways in a Bio-Economy

The main objective of the BIVAC project has been to test and develop small quantities of selected agricultural residues from the Euregio Rhine-Waal between Germany and The Netherlands for the purpose of creating new, sustainable and climate-friendly products for the feed, food, cosmetics and health market and this at competitive prices. Consequently, most of the resources have been invested into moving Technological Readiness Levels (TRL) up from 3 towards 5: thorough testing of prototyping in a representative environment. Already at TRL 6, *prototyping implementations on full-scale realistic problems* is required. Part of these 'realistic problems' are the availability of the residue streams in question, their distribution in the region, the infrastructure to allow large scale production and distribution as well as the necessary mechanisms by social and policy innovation to allow market uptake (consumption) as well as better regulations and supportive measures.

The resource analysis for residue streams from agriculture such as for the spotlight biomass streams vegetables, sugar beet and grass as well as for single crops such as leek, peas and onions has demonstrated that the participating companies are well located to access sufficiently large amounts of raw material to upscale their current business cases towards industrial levels:

- Sugar beet residue streams inside the Euregio Rhine-Waal amount to about 25.000t DMS. In the region where sugar company Pfeiffer & Langen is located (Elsdorf & Jülich), we actually find about 60.000t of DMS in a radius of about 45km. Other extensive sugar beet productions areas are West of Chemelot and in the Flevopolder.
- Onion biomass residues (peels and leaves) are more or less equally distributed within the Euregio Rhine-Waal with larger productions on the Dutch side. For BIVAC partner Biorefinery Solutions, ca 3000 DMS tons are accessible in the Euregio, with an additional 54.000 DMS tons from nearby Flevoland – allowing for large-scale protein production.
- Extensive grassland residues are – at least in principle – available at large quantities: 650.000 tons of dry matter in Euregio alone. With 55% protein content in grass-pulp, these are tremendous resources for overcoming two key problems: replacing soya as protein source and reducing nitrogen in remaining feed that is being returned to the famers.
- High value fractions of sugar as byproducts from the above feed and food innovation, but also the residue streams of sugar beet farming, can be used as key input for fermentation and processes at Phytowelt, allowing the production of astaxanthin, a colouring and flavouring agent as well as a health drug with a market value of €700 to €2,000 per kilo.

Despite these promising perspectives there are still numerous challenges ahead when moving further up the TRL-ladder. While regional cooperation taking a central role in the Dutch-German BIVAC project, the wider international context will always be part of a bio-economic approach that involves large industry partners. The examples of ongoing liasons between BRS and food giant Kühne or Phytowelt and biomass player Cargill illustrate that SMEs examine new partnerships for entering 'over-the-fence'-partnerships or attracting clients from remote locations. Grassa has raised € 2 million in a series A financing round led by Brightlands Venture Partners. Co-investors are LIOF, compound feed company Fransen Gerrits and current shareholders. With the funding, Grassa plans to further scale up its innovative biorefinery process and commercialise the product output. In addition, the company established a strategic partnership with compound feed company Fransen Gerrits for market introduction of selected products. In view of the current trends towards sustainable and circular construction, BIVAC partner NewFoss has teamed up with Province of Noord-Holland, Rijkswaterstaat, the Port of Amsterdam and others to exploit the harvesting of roadside grass for producing biobased insulation mats, produced in collaboration with the Swiss company Gramitherm.

However, entering new partnerships with national and international players does not mean that the region where the biomass comes from is not going to benefit from these new sustainable business models. For example, logistics is one of the economic pillars in which the Euregio Rhine-Waal excels. In terms of the sustainability asset 'multi-modal transport', the region – located between Antwerp, Rotterdam and Ruhrgebiet offers enormous possibilities with a string of inland ports along the Rhine (Duisburg, Neuss, Krefeld) and the Meuse (Venlo, Ooijen-Wanssum, Roermond, Wessem) and of course the well-developed train network with the Betouwe-line as its spine. Under the slogan 'Agropole', regional innovations in the food industry are manifested in a close cooperation among members of the quintuple helix consisting of policy, business, academia, civil society and community.

These summary results from the resource, impact and stakeholder analysis of the BIVAC project are meant to provide insights for strategic and practical choices for transition pathways towards a bio-economy at the level of Euregio Rhine-Waal and beyond.

References

AgriFood Capital 2018. Regio Deal - Noordoost-Brabant - De circulaire productie van dierlijke en plantaardige eiwitten aan de basis van een gezonde, vitale en economisch krachtige regio, 27 pages

ERW, n.d. Euregio Rhein Waal https://www.euregio.org/

Grassa 2020. Presentation at the Information Workshop on 18. November 2020 in MFA de Ynset, Friesland, The Netherlands

REPAiR, 2019 – REPAiR. (2019b). Resource management in peri-urban areas. Project REPAiR. Retrieved from http://h2020repair.eu

Wenger, E. (1998). Communities of Practice. *American Psychological Association.* Published. https://doi.org/10.1017/cbo9780511803932

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This research is supported by funding from Interreg Deutschland-Nederland:
Project name: BIVAC (Biobased Waardeketens voor nieuwe hoogwaardige producten en componenten)
Project number: 114123
Task number: 5.4 Locatie- en logistieke analyse

Published December 2021

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