THE REUSE OF GRASS WASTE IN SOUTHWEST DRENTHE

COMMISSIONED BY MUNICIPALITY HOOGEVEEN

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Group 3
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Preface

During our study period we learn a lot of skills. As a bachelor students of environmental sciences one of these skills is doing a research project. Of course a lot about doing research projects can be learned in class, but actually doing research is something totally different than just learning about it. For the course Environmental Project Studies we got the chance to do a research project for an existing client. The research will be done for the municipality of Hoogeveen. Our client is Herman Bakker from municipality of Hoogeveen together with Rosalie Rooze of Terra, a school on multiple locations in Drenthe. We are supervised by Eugenie van der Harst of the department Environmental Systems Analysis and Wei-Shan Chen of the department Environmental Technology. The overall supervision and course program come from the department Environmental Technology. As we are only students of Wageningen UR, the Wageningen UR cannot be held accountable for anything during this research.

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1 Introduction

There are a lot of cities/regions that strive towards a sustainable development where they try to combine an economical boost with environmental progress. This is no different for the Regional Cooperation of Southwest Drenthe. This cooperation is a partnership initiated in De Wolden between municipalities in Southwest Drenthe, entrepreneurs and education institutes. The partnership includes the municipalities of De Wolden and Hoogeveen. De Wolden and Hoogeveen also formed an alliance named Samenwerkingsorganisatie De Wolden Hoogeveen to realize a plan to utilize biomass waste streams in innovative ways. The biomass waste streams consist of roadside grass, biomass from ditches, woods and leaves. Right now around 800.000 kg of grass is mowed annually in the water boards of Reest & Wieden. It is picked up and some of it is used for composting, but not everything. The biomass that is not used is left at waste management companies. Samenwerkingsorganisatie De Wolden Hoogeveen is our commissioner in this research and our contact in this organization is Mr. Herman Bakker. The following section contains a further analysis of the problem.

1.1 Problem definition

Samenwerkingsorganisatie De Wolden Hoogeveen wants to do something innovative with untreated biomass, consisting of amongst other things, roadside grass clippings and wood waste. They have contacted entrepreneurs and firms that are willing to invest in bio-waste treatment possibilities. The problem is that the organization does not have a good overview of what the possibilities are with this bio-waste while there are a lot of ways to use it valuably and in a sustainable way. Wageningen University is asked to help in a consultancy to help the municipality (together with the other stakeholders) get a more detailed overview of some possibilities with this bio-waste.

Samenwerkingsorganisatie De Wolden Hoogeveen is our commissioner and therefore one of our main stakeholders. As mentioned before our contact within this organization is Mr. Herman Bakker. Samenwerkingsorganisatie De Wolden Hoogeveen will share the findings of this research with Regional Cooperative of Southwest Drenthe and the water boards of Reest & Wieden. Other stakeholders are the entrepreneurs and business firms willing to invest in this project. Table 1 is a list of stakeholders that were present during our visits in Drenthe.

Table 1 List of stakeholders present during our visits in Southwest Drenthe.

Company	Contact person(s)
Zuidema Groep Hoogeveen	Michiel Zuidema
Agraservice	Geert Lindenhols
Van Regteren groenvoorziening BV.	Herbert van Regteren
	Jacob Hennema
Waterschap Reest en Wierden	Robert Pannenborg
	Johan Snippe
Samenwerkings organisatie de Wolden Hoogeveen	Marjon vd. Brand Herman Bakker (commissioner)
Gemeent de Wolden	B. Everts
LTO	J.R. Meesters
Regional Cooperative of Southwest Drenthe	Jan van Goor
	Henk Lammers
Gemeente Westerveld	Sieb Klimstra
Project contact person between WUR and commissioner	Rosalie Rooze

After attending a meeting with entrepreneurs alongside the Samenwerkingsorganisatie we agreed that we would research treatment methods that can be applied to roadside grass. The entrepreneurs

and the organization were mostly interested in the possibilities with grass, which is only being composted at the moment. See appendix C.ii and C.iii for an overview of the meeting. In this paper we will provide an overview of the possibilities for grass reuse and indicate how these are applicable in Drenthe by using a Multi Criteria Analysis (MCA) and group discussion. This has led to the research question and sub questions below.

1.2 Research questions

Main research questions:

> *What treatments can be used to retrieve chemicals from grass from the municipality of De Wolden and Hoogeveen and can the grass be used as soil fertilizer or fuel afterwards?*

So we will first look at treatments available to retrieve valuable chemicals from grass. After knowing what remains form the grass after the chemicals extraction, we look if we can use the grass for other applications, such as making soil fertilizer, fuel or paper out the leftovers. To know if the grass still can be used for the other applications, we will research what is required to make these products. With this information we will develop a couple of scenarios and look which combinations are possible between chemical extraction and producing soil fertilizer or fuel. The municipality preferably wants to keep using grass as soil fertilizer and fuel, which explains why the second part of the research question is there.

We developed 6 sub-questions to answer our main research questions.
Sub research questions:

- What useable chemicals can be extracted from grass?
- What are possible treatments for the retrieval of these chemicals?
- Are these treatments applicable in Southwest Drenthe?
- What are the criteria for soil fertilizer and fuel?
- How can soil fertilizer and fuel be produced from grass?
- What is the most valued treatment to the entrepreneurs in Southwest Drenthe?

1.3 Social and scientific relevance

The possibilities to utilize bio-waste will be used by our commissioner. This makes our research socially relevant. Our commissioner alongside the entrepreneurs and the organization will use this assessment as a support for their arguments and the decisions they will make regarding the use of bio-waste in practice. Our report may also change the perception of roadside grass as being waste, to roadside grass being an opportunity. Our research will not develop any new theories or methods. We will be gathering information that is already available and bundle it together into an easily understandable package of knowledge, which can then be used by our client. We will compare different applications and try to find applications that can be combined.

2 Methodology

2.1 Research methods

Our project consists of three different methods: Literature research and interview, data analysis and a multi criteria analysis (MCA).

2.1.1 Literature and interviews

The first part of our project consists of literature research and interviews. With the interviews we gained knowledge on the current situation in Southwest Drenthe and the interest in area the stakeholders wanted to innovate. With the literature research we explored and researched options on what can be done with grass . Out all the options we choose a couple of options to do further literature research on.

2.1.2 Data analysis method

The second part of our research will be the analysis of the data. From the literature research we made an overview how the products are made and how they can be used. With the information we look if we theoretically can combined our chemical options with low technical options. With the combined options we make scenarios for our MCA. Out the scenarios and the collected data the criteria for the multi criteria analysis are formulated.

2.1.3 Multi Criteria Analysis method

The third part is about getting our entrepreneurs involved. With the collected data we will make a template for a multi criteria analysis (MCA) that contains the properties of the possibilities we found. MCA is a method to weigh options against each other based on criteria set up beforehand. These criteria are based on important aspects of the options, which in our case will be the designed scenarios. Each criteria for each scenario is gets its own weight. This tells something about how important the criteria is. In our MCA the criteria will be rated from 1 to 6, with 1 as value of the most imported criteria. We choose the scale 1 to 6; this way there is no middle option. The importance will be normalized. The normalized priority will be calculated to divide the priority given by the stakeholder through the sum of the total points that are distributed over the criteria. The sum of the normalized is one. To give the most important criteria the most weight in the normalized priority, this criteria will get a 6. While the least important criteria will get a 1. An example is that the most important criteria will have in the normalized priority a weight of 6/36, while the least important criteria in the normalized priority gets a weight of 1/36. To get an outcome, the stakeholders have to give each criteria a preference on how much they want of that criteria. An example is: the stakeholders wants a lot of end products or just one end product at the end of the chain. The total points for the criteria depend on the points given and the normalized weight of the criteria. The total number of points of a scenario will be the sum of the points calculated by each criteria. This total number of points give the number of points that the stakeholders want of a scenario.

We also give each scenario a scientific value per criteria. We did this this by ranking scenario's against each other. A score of 1 for a certain criterion for a scenario means that this scenario scores as 'needing the least' on this specific criterion. For more information about the scoring of the criteria per scenario, please take a look at Chapter 6.1. The value given for a criterion for a specific scenario is multiplied with the normalized priority and this is how the "real" number of points is calculated (Dodgson, Spackman, Pearman& Phillips, 2009). To decide which scenario fits best for the stakeholders, we compare the number of points given to the criteria per scenario based on scientific research and the number of points that a stakeholder has given to the criteria. When the comparison between the scientific number of points per scenario and the wanted number of points is the smallest, then that is the scenario that fits best. We will do this MCA by asking the entrepreneurs to prioritize the criteria and give points to each of the criteria.

2.2 Research resources

This report is based on literature research. The resources we use are scientific reports and articles. We also talked to the actors in Southwest Drenthe to find out what is currently done with biomass waste and which technologies are already available there to use for innovative biomass waste use, see Appendix C.i. To find out what can be done with grass clippings we rely on scientific articles, but also reportages of already implemented methods of grass reuse. Data about the situation in Southwest Drenthe will be provided by the client, which means that the validity and accuracy of the data will depend on the work of the client. Due to the lack of knowledge, we will not perform measurements ourselves. Our main effort is on the literature research to ensure the quality of our study.

2.3 Data analysis

With the literature research we collect data on the relevant reuse possibilities of grass. The criteria we use to decide whether the data are relevant are the following:

- Scientific
- Plant species in research
- Publishing date
- Relevance to search terms

With the collected information we write our different scenarios. Also we decide the criteria for the MCA. The other part of the data analysis is the actual MCA. With this we analyze what the entrepreneurs find the most valued option we researched, for detailed explanation see Chapter 6.1.

2.4 Definitions

Here we will shortly describe the words and terms we used in our research.

- Applicable in Drenthe: This will be bases on the criteria and the outcome of the MCA. The MCA will be performed by the stakeholders, so the MCA determines of a scenario is applicable in Drenthe. For list of criteria, see the chapter 6 Multi Criteria Analysis.
- Biomass waste: Mixture of grass clippings, or/and wood, or/and leaves, or/and plant rests, or/and water plant rests, or/and trash, or/and dirt collected from the nature or/and streets in the area of Southwest Drenthe.
- Chemicals: Minerals and other useful compounds and chemical compositions which grass contains.
- Composting: A process in which organic material is aerobically, with oxygen, digested. Compost is what is left over after composting. The compost can be used for fertilizing soil and soil structure enhancer.
- Entrepreneurs: People from Hoogeveen and De Wolden who are interested in investing in using biomass waste.
- Feasible: The technology efficiently enough to be profitable in Southwest Drenthe. Think about land use, whether or not it is more profitable to use these newfound technologies rather than the old ones. Is it worth spending money on new technologies?
- Fermentation: A process in which organic material is anaerobically, without oxygen, digested. The biomass is converting carbohydrates, such as starch or a sugar, into an alcohol or an acid.
- Fuel: A substance that can be used to generate heat or energy. In this case these will be pellets of grass.
- Grass clippings now: Trash, dirt, grass and other plants (e.g. herbs and flowers) mown (pretty short) at the side of roads and ditches left to dry for about 3 days (to remove seeds).
- Grass clippings, as they could be: Fresh or dry grass clippings with seeds, without dirt, trash and other plants and mown in various lengths.
- Most valued: This will be determined by the entrepreneurs when we let them value the criteria for the MCA.

- Possible: All treatments that are known are possible.
- Soil fertilizer: A substance that can be used to enrich the soil with nutrients which are vital for the plant's growth.

3 Grass

The bio based economy is a hot topic in The Netherlands nowadays. This reflects in the growing amount of projects exploring the possibilities of biomass. The aim of many projects is to produce products as high possible up in the 'biomass pyramid' that classifies by the value of its application shown as Figure 1. Figure 1 shows the biomass valorisation pyramid, this pyramid shows the added value of a product against its needed volume. For example: pharmaceuticals have a very high value and you only need a small amount of biomass to produce it. On the other hand, fuel does not have a high value, but you do need a lot of volume of biomass to produce it. Our research is on grass. In this chapter will be explained what grass consists of and a general overview of the possibilities of the use of grass is given. Later in the report some methods are explained in more detail. Eventually a MCA is applied by the entrepreneurs in the region to see which application is favoured.

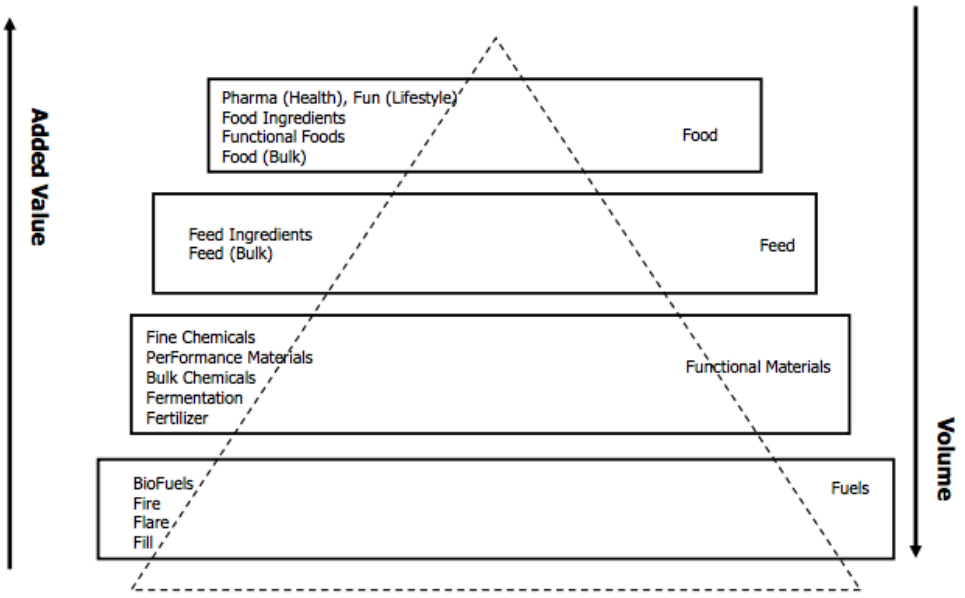


Figure 1 Biomass value pyramid used to classify biomass by the value of its applications within the domains of Food, Feed, Functional Materials and Fuels. Source: (Cat-Agrofood,2012)

3.1 Composting of grass

Fresh grass exist for the largest weight percentage out of water (70-90%), depending on the type of grass and the conditions when mowed. The other 30-10% exist out of dry matter. The dry matter exists of about (Van den Pol-Dasselaar,2012):

- 30% fibers
- 20% proteins
- 15% poly sugars
- 9% mono sugars
- 3% complex sugars
- 10% minerals
- 5% organic acids
- 3% fat
- 5% other compounds

Among these compounds you will find potassium and phosphorus in amounts that might be of interest to extract. Also a lot of metals are found in the grass, but at such low concentration that they are probably not of interest. This can be found in the Phyllis database.

3.2 Overview of the possibilities with grass

After harvesting the grass there are some possibilities process it. One if these possibilities is to leave the grass to biodegrade at the mowing site (this is done now in Drenthe). An overview of the possibilities is given in Appendix A.i.. The start product is roadside grass clippings. We shortly describe the processing routes.

3.2.1 Simple conversion

Simple conversion exist of methods that process the grass with one step in another product that is most likely directly ready to use. Grass can be composted what is already done in Drenthe. We shortly discuss this further in the report and use it as representation of the current situation. Another option is to use the grass directly as animal feed. This is done already by Grasdrogerij Ruinerwold and therefore not further discussed.

3.2.2 Refinery

The valuable compounds can be mined from the grass and used in the paper industry, as isolation material, or as chemical building bricks. This process is still in its infancy, but could have high potential. Grass Refinery if discussed in further detail further in the report.

3.2.3 Energy

The conversion methods that fall under this subject are less innovative and are applied already. Grass can be converted in pellets that can be burned or through fermentation bio-gas can be produced. Some applications will be discussed further in the next chapter.

4 Possibilities for using grass waste

This section presents possible ways to use grass waste in more detail.

4.1 The process of grass refinery in short

Grass refinery is the processing of grass into multiple products for multiple applications. Resource recovery from grass can assist in maximizing the economic value or environmental benefit of the plants. The individual products are taken out of the grass and what is then left of the grass can often be used to produce energy. This is also valid for grass refinery. Typically freshly harvested grass is grinded and then pressed to get two products: dry fibers and grass juice. An example of the pressing is shown in Figure 2.The juice contains many proteins and minerals that can be harvested by further processing. The fibers can also be used for several applications e.g. making paper or as isolation material (Van den Pol-Dasselaar, Durksz, Klop, & Gosselink, 2012). Some of the applications will be discussed in this report, and most of the applications are shown in Figure 3 on the next page.

Although grass refinery has been developed rapidly the past few years, only about three commercial initiatives for grass refinery are known in The Netherlands (Ysebaert, 2014). The idea is still in its infancy. Most initiatives are at the point of moving from the pilot phase to commercial production. The three Dutch companies will be shortly discussed in this chapter as well as their different production processes and the threats and opportunities for grass refinery.

Figure 2 Grass pressing, dry fraction (left) and wet fraction (right) source; http://www.groenegrondstoffen.nl/downloads/Infosheets/Pilot%20grasraffinage.pdf

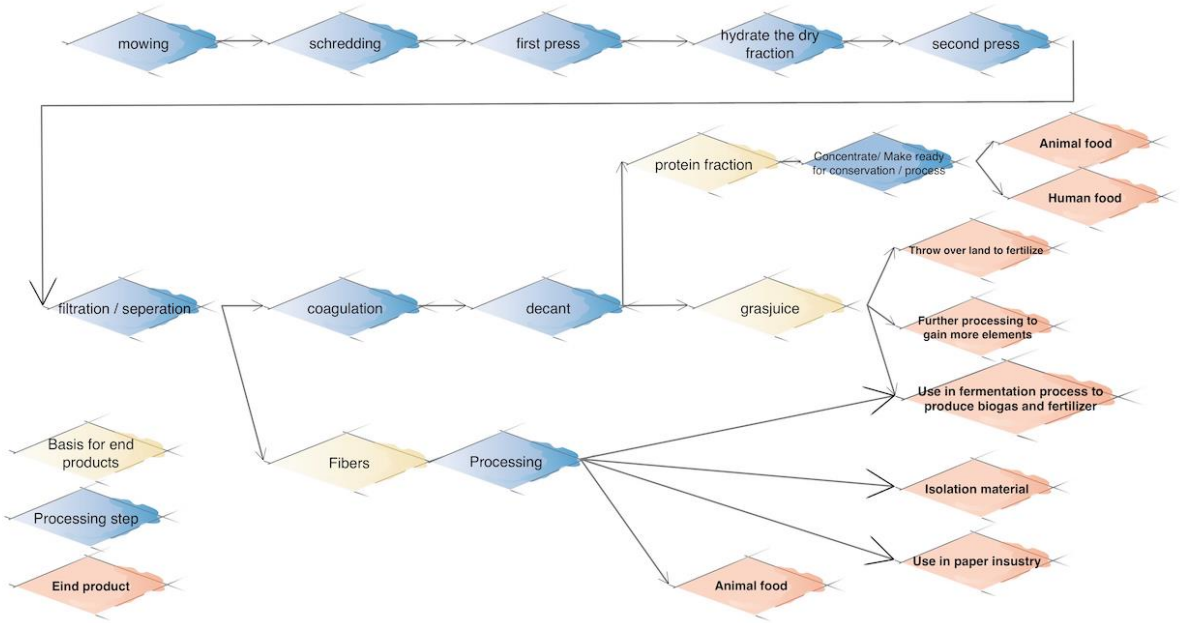


Figure 3 Block scheme of a typical process of grass refinery (Grassa).

4.1.1 Current experience with grass refinery in The Netherlands

The Dutch companies known for developing grass refinery are Grassa, HarvestaGG with the concept of Green Good Farms and the start-up Indugras (Ysebaert, 2014). In the 80's and 90's the potato organization AVEBE researched the possibilities of grass refinery in the project Grassa(Van den Pol-Dasselaar et al., 2012). A lot of current knowledge we have on grass refinery comes from this project. AVEBE decided to quit with the project because of financial reasons. With the current knowledge some entrepreneurs took up the project again and the company Grassa was founded in 2014. Grassa has led to world's first mobile grass refinery plant that produces a wet and dry grass fraction. The wet fraction is a protein rich liquid and can for example be used to feed cattle. The dry fibers can have applications throughout the paper industry or the other applications shown in Figure 3 (www.Grassa.nl). These applications are explained in more detail further on in the report.

HarvestaGG was founded by farmer Jan Cees Vogelaar. The aim is to build a plant to ferment grass from 15000 acres of land yearly to produce cattle feed, green gas and soil fertilizer. It is comparable to what Grassa is aiming to do (HarvestaGG, 2015).
The third company is Indugras. With superheated steam they opt to produce roughage and biogas as by-product. By heating the cell structure of the grass cell walls will get weaker which makes the compounds within the grass better reachable and thus usable. When fermenting the super-heated grass more biogas can be produced, it makes food better digestible for cattle and the sugars within the grass are more easily reached by enzymes (www.indugras.nl).

4.1.2 Strengths and weaknesses

It must be mentioned again that grass refinery is still in its infancy. The mentioned treatments in this report are still in the phase of being tested or just being operationalized. One requirement is that the grass needs to be fresh to use it for biorefinery, but it is not yet clear what the best way of conservation is. An uncertainty is that still a lot is unknown about costs and profits. Because of the variability in end products a lot of markets are involved(Van den Pol-Dasselaar et al., 2012).
Although there are some uncertainties and threats, there are also a lot of opportunities. There is a lot of grass available in the Netherlands. By using good grass management a higher grass production can be realized. Instead of wanting to get rid of the grass you start producing more grass to refine. The process is relatively simple and can be done on a big or small scale (Van den Pol-Dasselaar et al., 2012).

4.2 Proteins from grass

When refining grass it could be split into a wet fraction and a dry fraction. The dry fraction exists of about 30% fibers and 20% proteins and several other components (Van den Pol-Dasselaar et al., 2012). A press can separate the fibers (dry product) from the other components (protein rich liquid). Proteins are considered to be the main product from grass refinery (Van den Pol-Dasselaar et al., 2012). The proteins can be taken from the liquid resulting in a kind of paste. These proteins can replace soya shoot or other quiet expensive protein products in cattle feed (Van den Pol-Dasselaar et al., 2012). The process seems rather simple. You ad lactic acid to the grass-juice and heat it. In this process rennet flakes are formed that you sieve out. It looks like making cheese (Weerd, 2011).

Because the grass cell structures are broken more proteins can be taken out of the grass than when cows are directly consuming grass. The cows needs les feed. The protein paste is also edible for pigs and chicken. After extensive processing the protein can also become food for humans. NIZO has developed a method to extract the RuBisCo protein resulting in a bland and colorless protein isolate having good functional properties. Highly purified RuBisCo is odorless and colorless and has nutrient values equal or greater than known food proteins. It could serve in ice cream and desserts as foam. NIZO has requested a patent on the idea and the next steps will be to upscale and develop the extraction further (New food volume 14 issue 2, 2011).This could make it harder to get the knowledge you need to make human food from grass.

The grass fibers can also still be used to feed cows. Grass fibers can be compared to fresh grass. The bio-refinery can be compared with grass drying in the field. Taking out the juice has influence on how the grass can be preserved. Taking the proteins out makes the grass fibers better to conserve, but also sugars are taken out which is bad for the ability of conservation. First research concludes that it is possible to feed cows on conserved grass fibers. When the grass fibers are used like fresh grass is used now, cows seem to like it and it does not have effect on the cow's milk production. (grasrafinage en gebruik van grasvezel in de rundveevoeding)

4.3 Acids from grass

Next to proteins, there are also several acids that can be extracted from and produced by making use of grass. There are Lactic acid (LA) and Amino acid (AA). Next to these two acids there are more acids that can be obtained from grass. But for these two acids have their own method how they can be extracted and have a possible high yield. The acids can be obtained from whole grass, but also from grass juice ((Schaffenberger et al., 2012) and (Thang & Novalin, 2008)). The advantage of pressing the grass first, is that you will get a dry and a wet fraction of the grass before you will start the production steps of the acids. The wet fraction consists of the grass juice and the dry fraction contains all dry matter of the grass. Then it is possible to use the grass juice in the production of the acid and you can use the dry matter, or solid residue, for other applications such as fiber products, biogas or fertilizer production (Cherubini et al., 2009).

4.3.1 Lactic acid

LA is a natural organic acid and can be used in food and non-food industries, including the cosmetic and pharmaceutical industries. It is for example useful for the production of oxygenated chemicals, for plant growth regulators and for special chemical intermediates, but also as a feedstock for the production of biopolymer poly-lactic acid (PLA). PLA is used to make biodegradable plastic (Abdel-Rahman, Tashiro, & Sonomoto, 2010). The LA extraction out of grass is not yet used in practice, but there are pilot cases running.

The procedure can be divided in 4 main steps, which are (1) pre-treatment, (2) enzymatic hydrolysis, (3) fermentation and (4) separation and purification of LA. The goal of the pre-treatment is to break down the structure of the grass, mainly by removing the lignin and by separating cellulose and hemicellulose. The pre-treatment includes several steps. These are physical (such as grinding),

chemical, physicochemical and biological methods. In the pre-treatment it is important that there is no significant degradation in sugar content (Abdel-Rahman et al., 2010). When using the grass juice, the pressing can be done before the pre-treatment. In the case of grass juice, grinding is not needed anymore, but still purification of the grass juice is necessary before it can be used. The purification of the grass juice is necessary to remove lignin. To separate the grass in a wet and a dry fraction the grass can be pressed by a screw press. The pre-filtering of the grass silage juice can be done with a bag filter. What then is left of the juice can be purified with membrane devices(Schaffenberger et al., 2012). A fractionation efficiency of up to 85.0% from the silage into the juice can be reached (Haag, Nägele, Fritz, & Oechsner, 2015).

The second step is the enzymatic hydrolysis. Here is the grass (juice) depolymerizing (cutting the large molecules in pieces) the lignocellulose to sugars by means of hydrolytic enzymes (Abdel-Rahman et al., 2010).

The conversion to LA takes place during the next step: fermentation. The fermentation is done by Lactic Acid Bacteria (LAB). There are two kinds of LAB. First there are homo-fermentative LAB that produce LA as a main product and there are hetero-fermentative LAB, which alongside LA also produce acetic acid, ethanol (E) and carbon dioxide (http://textbookofbacteriology.net/lactics_2.html). The disadvantage of hetero-fermentative LAB is that there is more loss of dry matter in the fermentation process (Haag et al., 2015). The pH plays an important role here, because the optimum acidity to produce of LA lies around a pH of 3.79 (Abdel-Rahman et al., 2010). However the bacteria that are used in this process cannot grow below an acidity of 4. So for the highest yield of LA the pH has to be around 4, but not below. (Abdel-Rahman, 2011) LA has two optical isomers, which are d- and l-LA (Hofvendahl & Hahn-Hägerdal, 2000). Possible yields are: of 150 g/L l-lactate from glucose (Bai et al., 2004) and 87.2 g/L d-lactate from glucose (Tashiro et al., 2011).

The last step is the separation and purification of lactic acid. The purification of lactic acid is necessary to meet the standards of commercial applications. The fermentation broth is first neutralized by calcium carbonate. Pure lactic acid can be obtained by hydrolysis, esterification and distillation (Abdel-Rahman et al., 2010). There can be a 90.0% retrieval of the lactic acid from the organic juice (Haag et al., 2015).

4.3.2 Amino acid

Amino acid (AA) is a product that can be used in the food and flavor industry, but also for animal feed additives (Schaffenberger et al., 2012). The production of AA consists of the following steps: (1) pretreatment, (2) ion exchange and (3) purification. For the production of AA the grass silage juice is used. The pretreatment is purification of the grass juice, because certain compounds have to removed out the grass juice before it can be used. The is done by making use of the same process as described in the section about lactic acid. So the grass is pressed and then filtered by membranes (Schaffenberger et al., 2012).

The seconds step is to separate the amino acids from the grass juice. This can be done with an ion exchanger. With this the amino acids are also purified. In the pilot of Schaffenberger, M., 2012 there are some possible yield described. The yield could differ per the different parameters used for the ion exchanger. With these mixed parameters the possible yield of AA varied from about 6 to about 10 kg per batch run purified grass silage juice. The table below, Table 2, gives concentration of certain compounds in the grass that can be extracted.

Table 2 Composition of the grass silage juice from the report of Schaffenberger, M., 2012.

Component	Concentration [g/L]
Amino acid	17.5
Lactic acid	18.6
Aspartic acid	1.53
Acetic acid	5.21

4.4 Lignin from grass

With the global dependence on fossil fuels and chemicals, declining amounts of fuel supplies as well as depletion of chemicals becomes of growing concern. Another way of obtaining fuel supplies and chemicals is of much need. Conversion from biomass into fuel and chemicals may be a solution for this problem, especially when looking at non edible biomass which cannot be used for food production so the impact on food security is minimal(Azadi, Inderwildi, Farnood, & King, 2013). Next to retrieving acids from biomass, as discussed in Chapter 4.3, other chemicals can be extracted from biomass as well. In this part the use and extraction methods of lignin from grass will be illustrated.

Lignin is a complex natural polymer, which is constituent in almost all dry land plants cells. Lignin causes rigidity in plants, like in wood and straw. Where almost all plant cell polymers consist of multiple monomers, lignin consists of aromatics. These aromatics cause the rigidity of plants because they have very complex bindings. Three different kinds of lignin exist and their compounds differ slightly. Trees grow much higher because they have a lignin content of 20-30% lignin, where grasses contain less than 20% lignin (http://www.lignoworks.ca/).

Although lignin is the second most abundant natural polymer in the world, only exceeded by cellulose, lignin is still seen as a low quality side stream of the paper making industry or a by-product of the production of bio-ethanol (http://www.wageningenur.nl/en/Research-Results/Projects-and-programmes/Lignin-Platform.htm). However, lignin may serve as a main source for aromatic chemicals and phenolic compounds (compounds containing hydroxybenzene). It can also be used as wood adhesive or fuel additives(Calvo-Flores & Dobado, 2010).

To get a stable and cost-effective production of lignin for materials, chemicals and other applications valorization of all lignin-containing fractions should be done. This can be done through biorefinery, which separates biomass in different fractions after which it can be used for further conversion into products. The aim is to do this in as few steps as possible, while maximizing the value of the products. The process of recovering lignin from biomass consists of two different steps: primary biorefinery and secondary biorefinery. Primary biorefinery is the step during which the lignin is extracted from biomass, after this step secondary biorefinery converts this lignin into useable products (Agentschap NL, 2011). Two different types of extracting lignin from biomass exist: (1) degrading lignin into a solid fraction and a liquid fraction and thereafter removing the solid fraction (pulping) and (2) thermochemical valorization of lignin (Azadi, Inderwildi, Farnood, & King, 2013).

Thermochemical valorization can be split in gasification and depolymerization. Gasification has high product selectivity and a high feed flexibility. When using oxygen instead of air gasification can also reduce carbon emissions within the mill. However, gasification is a very complex process and more research is needed to commercialize it. Therefore we will not discuss it here in more detail (Azadi, Inderwildi, Farnood, & King, 2013).

Next to gasification depolymerization has less severe operating conditions, which makes it more applicable. However, conversion processes are very low and there are many different monomeric

and oligomeric (a few monomers combined) products, for whose formation a lot of hydrogen is needed. Those monomers and oligomers like hydrocarbons and char should be put to use to make this process viable. Hypothetically these by-products can be used to make syngas by gasifying it. It that case both depolymerization and gasification can be combined. Unfortunately there is still little known about this process and one of the criteria of our research is that the information we gather is useful for Drenthe, which in this case it is not (Azadi, Inderwildi, Farnood, & King, 2013).

One of the main advantages of degrading lignin into a solid fraction and a liquid fraction is that the procedure is already happening in the paper industry. In the paper making industry pulping is used to fractionate lignin from the biomass, this lignin is a by-product and it is mostly just used for combustion while it can be used for much more (The Lignoplatform WUR). Grass is not the most usual material to make paper from, but it actually is the oldest. Making paper from grass has been done for over 1900 years, but nowadays grass pulping only account for 6% of the global pulping processes (Pahkala, Paavilainen, & Mela, 1997).
We will discuss the kraft process and sulphite pulping because together they account for almost 100% of all pulping processes. Next to these two processes we will also discuss the organosolv process, since it is a rather new method and compared to the other two processes it is quite environmentally friendly (Azadi, Inderwildi, Farnood, & King, 2013). The kraft process can be used for making paper from grass (Madakadze, Radiotis, Li, Goel, & Smith, 1999). More research on organosolv and sulfite pulping is needed to make conclusions about the use of these processes with grass.

4.4.1 The kraft process

The kraft process is the dominant pulping process in the world, it accounts for almost 90%(Azadi, Inderwildi, Farnood, & King, 2013) of all pulping. Cellulose fibers are isolated by dissolving lignin and hemicellulose from biomass in a solution of Na_2S and NaOH (Azadi, Inderwildi, Farnood, & King, 2013). The solution of Na_2S and NaOH is heated to 155-175°C for several hours, after the heating process a solid fraction containing cellulose can be separated from a lignin containing liquid fraction (Garcia Calvo-Flores, 2010). In the beginning of the process the pH is between 13 and 14 but it decreases due to freed organic acids from hemicellulose and lignin. The dissolved lignin and hemicellulose leave the process with an aqueous stream. The content of lignin in this stream differs from 29-45% for papermaking and 8-16% for grade making. The lignin in this process undergoes a lot of structural changes which makes the binding between carbons more refractory. This makes it more difficult to recover the lignin. However, acidification with mineral acids or carbon dioxide makes recovering lignin possible (Azadi, Inderwildi, Farnood, & King, 2013). After addition of these acids to neutralize it, the lignin is dried. The lignin recovered from the kraft process is insoluble in water and only soluble in an aqueous solution(Calvo-Flores & Dobado, 2010).

4.4.2 Sulphite pulping

Sulphite pulping accounts for almost 10% of the pulping processes. One of the main advantages of sulphite pulping is that it is not pH dependent. By changing chemicals and their dosage the process can take place at almost the entire pH range (1-13). The temperature of the process differs between 120-180 °C (Azadi, Inderwildi, Farnood, & King, 2013). The lignin recovered from this process is more similar to the original lignin, due to the less aggressive process than kraft (Calvo-Flores & Dobado, 2010).

The abovementioned processes are both part of the paper making industry. At the moment only 2% of the produced lignin in this industry is commercially exploited. The other 98% is directly used for combustion to produce energy (Calvo-Flores & Dobado, 2010).

4.4.3 Organosolv process

Organosolv pulping mostly makes use of sulphur free organic solvents for the extraction of lignin from biomass. Examples of solvents used for organosolv are alcohols and organic acids. Advantages of the organosolv process are that it is more environmentally friendly due to the use of organic solvents. Some organosolv processes are able to separate all cellulose, hemicellulose and lignin fractions which makes it easier to implement these separate fractions, which makes it more economically profitable. Because the lignin extracted by the organosolv process does not contain sulphur and because it is less condensed (due to a lower boiling temperature of the organic solvents) it is more suitable for technical applications and further conversions than the lignin from the kraft process or sulphite pulping. However, organosolv is not yet used on a big scale due to it being a rather unknown technique (Azadi, Inderwildi, Farnood, & King, 2013).

After the primary biorefinery step secondary biorefinery can be used to produce more applicable materials. Lignin can be used in many ways and for many different uses. Some direct applications are known, for example as a component in the health industry. Lignin contains free-radical scavengers, which makes lignin a natural antioxidant. Kraft lignin has shown antioxidant activity in red blood cells of humans, water soluble lignin components have shown anti-viral activity and even antibiotic and anti-carcinogenic properties have been found (Calvo-Flores & Dobado, 2010). These properties can be used for example in pharmaceuticals.

Several compounds of lignin can be used in different ways. Lignin-sulphates can be used as adhesives or binders. Ecofriendly materials can be made from lignin-based polymers. A mixture of different lignin based compounds in combination with natural fibers can be used to make bioplastic. The plastics are entirely recyclable. Lignin can replace up to 50% of general used binders or adhesives in the wood industry (Calvo-Flores & Dobado, 2010). Using lignin instead of general used adhesives is not only more environmentally friendly, but it is also cheaper. Lignin can even be used to produce vanillin, which is a flavouring ingredient in many beverages, foods and even in pharmaceuticals(Calvo-Flores & Dobado, 2010).

4.5 Paper production from grass

Since long wood has been the primary source for fibers in paper production, but since recently the possibility to use non-wood sources for paper production is being investigated (Wisur, 1993). Because the supply of wood is finite it is useful to find other sources for paper production. As became clear in the sections above that grass can be separated in a dry and wet fraction. The wet fraction can be used to produce all kinds of chemicals, but the dry fraction is then still left over. The dry fraction consists for an important part of grass fibers. These fibers can be used to produce paper or cardboard. This could provide a solution for wood supply issues and could be beneficial too for the environment (Camarero, 2004). Research about the possibilities of grass-based paper and cardboard is in progress, for instance by a company called Eska (http://www.eskagraphicboard.com/nl/about-eska/research-innovation/innovation). Another company called Huhtamaki already produces egg packaging that consists of 50% grass (http://www.huhtamaki.com/-/greenest-innovative-egg-packaging-made-with-grass-fibers). The product is called GreeNest and Huhtamaki claims that production of the packaging accounts for a 60% reduction in water use and a reduction of 10% in greenhouse gas emissions compared to conventional paper production (http://www.huhtamaki.com/-/greenest-innovative-egg-packaging-made-with-grass-fibers). Although these numbers cannot be confirmed, it sounds promising.

The grass that is used for egg packaging comes from nature reserves that are managed by Staatsbosbeheer, the Dutch governmental organization that manages forestry and nature reserves (NOM, 2014). This is quite similar to the source of grass in Drenthe: in both situations the grass is retrieved from (semi-)natural areas, so the retrieved grass consists of a mixture of grass species. The

grass should be ‘pure and natural’, however, according to a promotional video for GreeNest (https://dreambroker.com/channel/ayxrvvw2/boqpumu1). If this indicates anything at all, it probably means that the grass yield should not be polluted with other plants. The video for GreeNest also states that a special mowing technique needs to be used to prevent sand and dirt from polluting the grass yield. If entrepreneurs in Southwest Drenthe want to produce paper from roadside grass, they have to take into account that they will probably have to buy new lawn mowers or upgrade the current ones.

The fibers of the grass can be separated from the liquid fraction of the grass by chemical treatments such as acidic hydrolysis, alkaline treatment or enzymatic treatment (Smole, 2004). The process of separating fibers is called retting. Retting is executed ideally in a biorefinery. After retting the fibers can be used to produce pulp, which can be used to produce paper or cardboard (Smole, 2004). Pulping is necessary to separate various types of cells, other than fibers, from each other and is done by diluting the fiber source (in this case grass) in a liquid bath. The consistency of the liquid can differ. The liquid containing the fiber source is centrifuged to separate the cells. Pulp obtained from grass has other characteristics than wood pulp, so the current steps used for producing paper need to be adjusted. For instance paper from grass pulp is harder to bleach, so new methods to efficiently and sustainably bleach the paper have to be found (Camarero, 2004). The necessary techniques are not completely developed yet, but it has been shown that it certainly is possible to use grass as source for paper.

4.6 Pellets

Instead of for producing paper the dry fraction of the grass can also be used for making pellets. Pellets consist of biomass, compressed into grains by pellet production devices, and can be used for combustion. Pellets are, because of their compact, durable and easy-to-use capacities an efficient combustion source (Larsson, 2008). Grass can be a suitable source for pellets with high combustion efficiency. There are several companies which sell readied devices for making pellets for private use (https://www.youtube.com/watch?v=4Cq63ak0Fmw, http://www.makepellets.com/). Since in principle only a readied device needs to be bought pellet production is an easily accessible method for using grass in a useful way. However, there are several ways by which the efficiency and quality of grass pellets can be improved. These will be discussed in this section.

Factors that indicate high pellet quality are high bulk density (mass of fuel per volume), high durability/solidity, low amount of ash and low amount of moisture. For combustion suitable diameter and length of the pellets and low content of minerals also indicate high pellet quality (Cherney, 2013). These factors for instance depend on the species of grass used, on the pretreatment and on the pellet production process within the devices (Cherney, 2013). In Southwest Drenthe especially the latter two processes can be optimized to retrieve an as high as possible pellet quality.

What species of grass need to be reused in Drenthe is not known, so what pretreatment will work best is uncertain. By using data of other grass species, however, an indication about the most suitable pretreatment steps can be given. To start with the harvest time plays a role (species researched: Phalaris arundinacea). Grass harvested during springtime has lower amount of minerals, which makes combustion more efficient (Burvall, 1997). Pre-compaction of the same grass species led to a continuous production process of pellets (Larsson, 2008).

To produce high-quality pellets with a stable and continuous process the moisture content of the grass should be at least 13.8%, the machine temperature should be less than 83 °C and the raw material density should be higher than 324 kg/m3 (Larsson, 2008). The best production of pellets could probably be reached with a machine temperature of 30 °C, with a high grass moisture content and with a grass temperature of 30-40 °C (Larsson, 2012). The bulk density should be as high as possible. To ensure that high-quality pellets will be produced, the entrepreneurs in Southwest

Drenthe should take into account the factors given and should use a pellet manufacturing machine that allows to measure up to these factors.

4.7 Aerobic composting, Fermentation (Bokashi) and Soil Amendments

Biowaste can be used as soil amendment after composting processes. In this chapter the processes of aerobic and anaerobic composting will be discussed. Afterwards, there will be a small section about the quality and the rules of soil amendments.

4.7.1 Compost

It can be very environmentally sustainable to reuse grass and other organic materials especially if you have around 800.000 kg every year of grass clippings. One may have different motives behind the decision to re-utilize biowaste or to apply it in other methods. Examples of these motives are limited land for landfills, generated Green House Gases (GHG, such as methane) and shortening the nutrient cycles such as phosphorus and potassium (Merfield, 2012).

The conventional non-landfill approach for dealing with organic bio-waste is composting (C. Merfield, 2012). As the name may suggest, composting is the process that decomposes raw organic waste material in a natural way, breaking the large complex chemicals to smaller basic building blocks. These basic molecules are biologically stable and can used to improve soil qualities(Cooperband, 2002).

In order for this decomposing process to take place a myriad of organisms that all have their different roles is required. The decomposing process that is used the most is aerobic which means the microorganisms need oxygen to function. The following simplified equation displays the biochemical process.

Added Microorganisms gives: Organic Matter + O_2 → CO_2 + NH_3 + Products + Energy
Temperature is a prominent factor in order to stimulate microbial growth and activity. These microorganisms can be split in to 3 groups: The cryophiles (0-25 °C), the mesophiles (25-45 °C) and the thermophiles (>45 °C) (Ozores-Hampton, Obreza, & Stoffella, 2001).

If under the right conditions, the whole biological decomposing process can be split into 3 phases. First the mesophilic organisms decompose the organic material, these microorganisms as stated before function at a temperature of around 25-45 °C. This phase lasts for a couple of days. In the second phase the thermophiles take over and decompose organic material. This occurs at a temperature of at least 45 °C or higher, and this phase may last several months. The last phase is the cooling and maturation phase which also lasts several months (Trautman & Olynciw, 1996). In Figure 4 you can see an overview of the whole process.

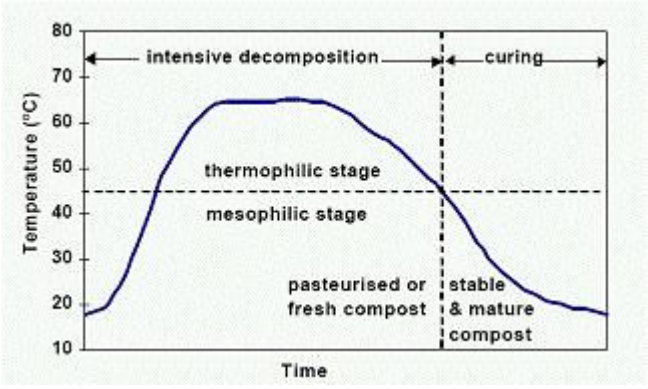


Figure 4 Temperature curve of a typical compost process. Source:(McDonald, Wilkinson, & Stead, 2015).

This composting process takes place under the right conditions as mentioned before. To provide the condition for the microorganisms to carry out composting is crucial for the success of composting. There are 4 main factors that determine the success of the process.

1. The chemical composition of the organic material
2. The physical size/shape of the material
3. The population of microorganisms involved
4. The seasonal difference

For optimal microbial activity the carbon and nitrogen ratio should be 20:1 to 40:1. The environment would be ideally at a ratio of 23-35:1 for keeping the most nutrients after the process. If the C: N is lower than 20:1 the organisms will have an over-abundance of N and they will produce ammonia. This ammonia will be released to the atmosphere and may cause odor nuisance. Grass clippings have a C: N ratio of 15:25 (Cooperband, 2002).

Another factor that plays a role is the seasonal difference between the cuttings. A study conducted in Denmark concluded that the chemical composition of garden waste showed seasonal variation (Boldrin & Christensen, 2010). The concentrations of organic compounds and carbon were the highest in the winter, when there's a clear presence of woody material. Ash and metals were higher during the summer, when a lot of soil was present in garden waste. Nitrogen was very high in the summer considering the fact that there is a lot of grass clippings in the garden waste. You can find a clearer view on the seasonal concentration differences between the chemicals in Appendix A. ii.. Although this study is not conducted in Drenthe, it is important to consider the fact that grass clippings and other garden wastes may have different compositions depending on the season in which it was cut (Boldrin & Christensen, 2010). So to have optimum and satisfying results, more research on the grass composition in Drenthe should be performed.

Usually different types of bio-wastes are mixed together to achieve the right composition. The moisture content is also very important. The waste should not be too wet, nor to dry, the acceptable moist content is between 40-65%. The pH also plays an important role. The microorganisms are most effective when the pH is between 6.5 and 8 and an environment is also acceptable when the pH is between 5.5 and 9. If the pH surpasses 7.5 here ammonia can also be released. The temperature is acceptable between 43 and 66 °C and is ideal between 54 and 60 °C. (Cooperband, 2002)
The availability of oxygen for composting is also a very important factor regarding that we are dealing with aerobic organisms. The acceptable oxygen concentration would be >5% and it would be ideal if it's 10% or more.

During composting the bio-waste is aerated by regularly turning the windrow with a grinder. This gives oxygen the chance to penetrate and keeps the process aerobic. This is necessary to stimulate the growth of microorganisms. As mentioned before, these microorganisms break down the organic matter. The energy produced by the microorganisms, heats up the windrow to about an average of 60.5 °C.
After composting, the rest product is a relatively stable material. It consists mostly of material that was not decomposable, such as cellulose and especially lignin. The compost can be used as soil fertilizer because it contains a great concentrated amount of atmospheric nutrients (N, C) and lithospheric nutrients(P, K, Ca) (Merfield, 2012).

4.7.2 Fermentation (Bokashi)

Fermentation is a natural process which occurs under different circumstances than composting. Fermentation is an anaerobic process, so it uses different microorganisms that only function under low or no oxygen environments (C. Merfield, 2012). The biochemical equation corresponding to this process is: Anaerobic Bacteria and Organic Matter → CO_2 + NH_3 + Products + Energy + H_2S + CH_4.

One form of fermentation is Bokashi. Bokashi is a product mix that contains a selected group of special microorganisms, seashell lime and clay minerals developed by Prof. Teruo Higa (Hitman, Bos, Bosch, & van der Kolk, 2013). This mix with Effective Microorganisms (EM) includes microbes such as: Lactic Acid bacteria, photosynthetic bacteria, yeasts, actinomycetes and fermenting fungi. They are added to the bio-waste windrow to eliminate harmful bacteria and stimulate the bacteria that are beneficial. In order for this process to be anaerobic, these rows will also be closed (Hitman et al., 2013). A picture of this can be seen Figure 5. In the EM are used as an inoculant or compost starter by using a carbon source (e.g., wheat bran) or a liquid form via microbial spray (e.g., activated EM). After adding these organisms the fermenting will begin.

For fermentation a higher C: N ratio (10:1) is required in order for the microorganisms to function because complex compounds such as cellulose and lignin are not used. During the process the temperature remains quite constant (C. Merfield, 2012). As stated the process is anaerobic so there is no need for aeration or for oxygen to be present(Hitman et al., 2013). But when using Bokashi EM factors such as the C: N ratio and moisture are of less importance because the EM will setup the environment so the process can take place (Footer, 2014).

Figure 5 Windrows in Bokashi fermentation (The organic coach in natural farming methods, 2010).

Another form of fermentation is dry fermentation. Dry fermentation is done by bringing biomass into a closed reactor. To accelerate the process inoculum from an older batch is added. You bring in the bacteria that breakdown the biomass and this speeds up the process. The first phase of breaking down the biomass is an aerobically process. The oxygen present in the reactor is used in reactions by the bacteria to breakdown the biomass and CO_2 is formed. After a while all the oxygen has been used by the bacteria. Under anaerobic circumstances bacteria produce methane (biogas) and CO_2 while breaking down the biomass. The biogas can be harvested and used to generate electricity and heat. In the example of Orgaworld in about 30 day's most of the biomass is transformed into biogas and a rest product, digestate. The digestate can be used to process further into soil fertilizer (http://orgaworld.nl/).

4.7.3 Soils Amendments

According to one study only 3.2% of the original organic waste gets lost during the anaerobic composting process compared to 62.2% of the conventional way of composting. (Hitman et al., 2013) They also found out that there are more nutrients that remained in the rest product of Bokashi. These include, atmospheric nutrients (carbon, hydrogen, oxygen) and water. What this nutritional difference exactly means for the addition of fertilizer on soil needs further research. But both aerobic and anaerobic compost can be used as soil amendments (Hitman et al., 2013).

Both aerobic and anaerobic composting are a source of organic matter and therefor have the ability to improve soils. Adding compost to soils increases the soil fertility and it can help reduce other fertilizer requirements up to 50% (Cooperband, 2002).

In order for compost to be used as soil amendment or fertilizer in The Netherlands the substance has to comply with the Fertilizer Laws (Rijkswaterstaat Leefomgeving, n.d.). In chapter III from the *Uitvoeringsbesluit Meststoffen* the conditions in which the compost has to be in are described. In article 17 it says that compost can be used as fertilizer if:

- There are no biologically degradable parts with a diameter bigger than 50 millimeters and it is not allowed to have more than 0.5 weight percentage of foreign non-biological degradable soil parts.
- There is minimum of 10 weight percentages organic material of the dry matter
- In cases of preparing the soil, it has to be clean soil. This means soil that complies with the *achtergrondwaardes* in annex II, below table 3 in the *Regeling Bodemkwaliteit*
- The quality complies to annex II, below table 3 of the *Uitvoeringsbesluit* recorded maximum values of heavy metals.

Source: (Rijkswaterstaat Leefomgeving, n.d.)
So considering these laws, not every compost can be used as soil fertilizer. So before the application of compost as an amendment for soil, the composition and the quality should be controlled.

5 Scenarios

We divided the possible applications of grass clippings we found into scenarios: we combined the processes that would fit well with each other, based on complexity and on the compounds of the grass that are still available after a process within the scenario. This led to the following 5 scenarios:

1. Composting and soil amendment
2. Simple biorefinery
3. Medium biorefinery
4. Complex biorefinery
5. Direct application of grass

In this section each scenario will be briefly clarified. As described in the Research methods we will do a Multi-criteria analysis (MCA) to find out which scenario is most appropriate for the entrepreneurs in Southwest Drenthe. How the MCA is executed will be discussed in the next section. Conditions of the scenarios are also discussed.

5.1 Scenario 1: Composting and soil amendment

The first scenario describes what we called the blank scenario. Composting biowaste and selling it as soil amendment is already extensively applied in Drenthe. It is a well-known phenomenon within the scientific community and besides having some biowaste, not much more is needed to start.

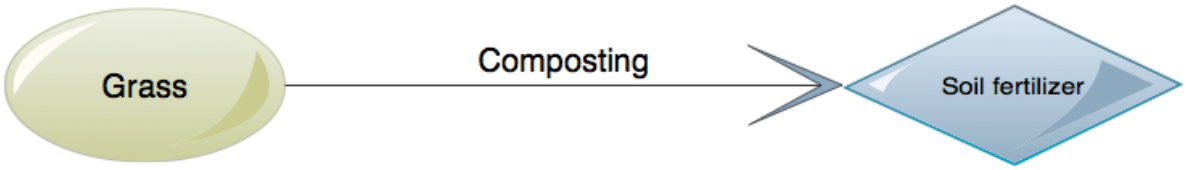


Figure 6 Composting in a block scheme.

5.1.1 Process

The simple process of composting is depicted in Figure 6. Below is a concise description of the practical application of the composting process retrieved from Public Works and Government Services of Canada, 2013. First thing that happens in the process that eventually leads to soil amendments is the removal of non-compostable material in the biowaste (e.g., packaging, cans and glass) and large pieces that may damage or slow the composting process. Then the chemical and physical preparation of the feedstock has to be set at the optimal composting conditions. Once the right composition has been reached, the feedstock is placed in windrows, piles or vessels where the aerobic decomposition starts. This is called the active composting. Depending on which machinery is used, there should also be somebody present to aerate and mix the feedstock regularly to keep the process aerobic. Afterwards large pieces such as wood chips and other coarse bulking agents are removed and used in the preparation of new feedstock. Subsequently it is time for the curing. This is where the microorganisms convert carbon into carbon dioxide and humus, and nitrogen into nitrates. Right after this process the compost should be tested for the presence of biological activity (stability) and for the presence of phytoxins and their unwanted chemicals (maturity). If there is still biological activity it means that the process is not done yet.

5.1.2 Conditions

Despite the fact that it takes quite some for the compost to be ready, not much time is needed to start. If you have the space and biomass that is required, you can start instantly without the help of other business partners. It goes without saying that it is beneficial to work together if you want to compost on a big scale. This helps with the resources and financial aid. But it is also possible to just

compost in your backyard with almost no help from others. Using compost as fertilizer is in the second lowest level on the valorization pyramid.
The environment of composting is relatively safe. Aside from the odor nuisance there is not much danger involved in the process. As mentioned in chapter about composting (insert reference) there are a few laws and regulations composting material has to comply with before this can be applied on land. These laws and conditions for soil amendments were shortly discussed and can be found in chapter III of the *Uitvoeringsbesluit Meststoffen.* Compared to the other scenarios, these regulations are not much.

5.2 Scenario 2: Refinery simple

Composting is already applied in Southwest Drenthe, but the stakeholders want to find new ways to use grass waste. A more advanced yet not very complicated process is simple biorefinery.

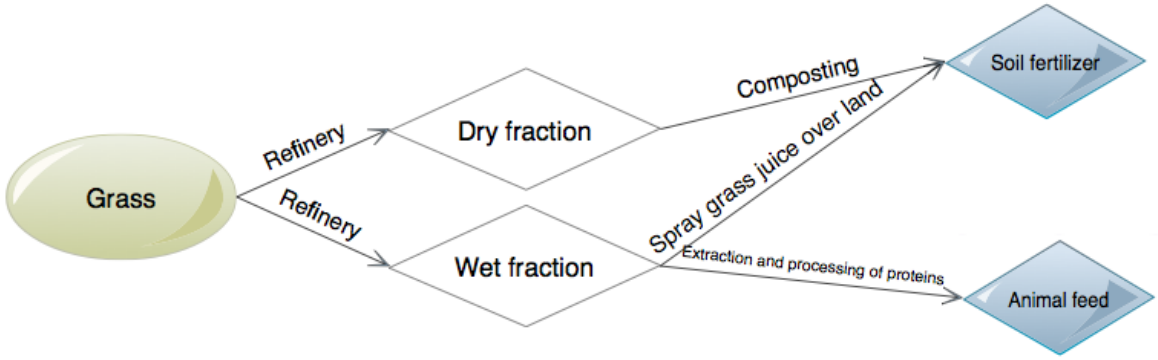


Figure 7 Simple grass refinery in block scheme.

5.2.1 Process

As can be seen in Figure 7 grass can be divided into a wet and a dry fraction. Both fractions can be used for different processes to acquire different end products. With a press, e.g. a screw press, the dry matter can be separated from the liquid fraction in grass. The dry matter can be composted and then be used as soil fertilizer. The wet fraction, or grass juice, can also be used as soil fertilizer, but it can also have other applications. Out of the wet fraction proteins can be extracted. This process has two steps. Step 1 is to add lactic acid to the wet fraction; step 2 is to heat the mixture. This way the proteins and the lactic acid clump together. The lumps can be filtered out of the liquid. Then it is left to dry and can be used. (Trouw, 2011) The proteins can be used as animal feed and can replace soya shoot or other quiet expensive protein products in cattle feed. As shown in Figure 7 scenario 2 has two types of end products, soil fertilizer and animal feed. The amount of steps in the process is quite limited: through refinery the biomass is split into two fractions, after which both fractions will be converted into the end products.

5.2.2 Conditions

For scenario 2 more research is needed than for scenario 1. In scenario 1 only research about the grass is needed to optimize the composting process. In scenario 2 composting is combined with the production of animal feed from protein, this production process comes with new variables which need to be examined more for maximizing the process. The amount of regulations with regard to the safety of working conditions is more than for scenario 1, for compost there are some rules but the amount of rules is less than for scenario 2 due to the making of animal feed. For the process of producing protein, however, some more safety measures are needed due to working with chemicals like lactic acid to extract the protein. The amount of regulations for feed makes the total amount of regulations higher than for scenario 1. In this scenario partnerships are useful. For the use of bio refinement a refinery is needed which does cost some money, but compared to the other biorefinery scenarios these costs are quite low, because only animal feed and soil fertilizer are endproducts so

the processes needed in the biorefinery system are not that complex. Partnering with others in the use of a refinery might be less risky, because investment can be divided by partners. It can take some time before scenario 2 can be actually implemented since a refinery needs to be arranged, lactic acid has to be bought and machinery for the protein production process needs to be applied.
Scenario 2 is in the third level of the biomass valorization pyramid, Figure 1. The risks of scenario 2 are especially with regard to the use of protein for animal feed. The use of protein from grass for animal feed is tested and cows like to eat the end product (see Chapter 4, section Proteins from grass). However it concerns feed and feed safety is restricted with regulations, so there is a risk that the costs to measure up to the regulations are going to be high. Investments on biorefinery and machinery for retrieving the protein from grass should be made. The proteins from grass could replace proteins from soya, so there are possible resource savings in this scenario.

5.3 Scenario 3: Refinery medium

A step further than simple biorefinery is the medium biorefinery scenario. Just as in scenario 2 the grass is first separated in a wet and dry fraction. The applications of the 2 fractions are different, as can be seen in Figure 8. Instead of making compost out of the dry fraction, pellets are now produced to generate heat.

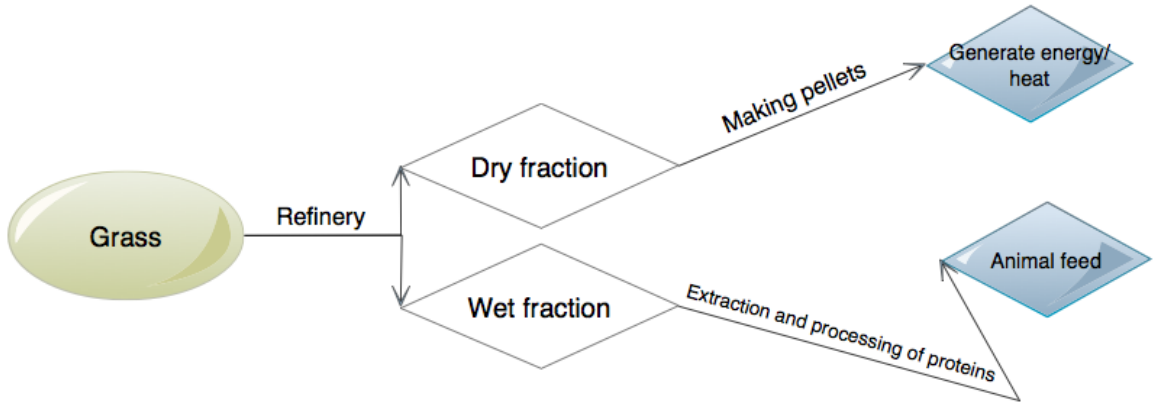


Figure 8 Medium grass refinery in block scheme.

5.3.1 Process

These applications need more processing, knowledge, machines and thus investments than scenario 2. We cannot specify how much more exactly. The wet fraction is processed as described in scenario 2 to extract proteins for animal feed. The fibers in the dry fraction are either prepared for silage by adding chemicals for conservation of the grass fibers, or made into pellets. Pellets can be made by compressing the grass into grains with special machines that are for sale to do this.

5.3.2 Conditions

This scenario is comparable to scenario 2, so the criteria in this scenario are quite similar to those in scenario 2. Because the biorefinery is more complex in this scenario there are more possibilities with the end product, there are more process steps, more knowledge and research is needed, probably more safety measures have to be taken, more cooperation is needed, the application term is longer, there is a higher investment needed thus the risk is higher too and, last, more natural resources can be saved. We thought regulations and the level of the end products in the valorization pyramid would be the same as in scenario 2.

5.4 Scenario 4: Refinery complex

5.4.1 Process

Complex grass refinery starts again with the separation of the wet and dry fraction in the grass as explained in scenario 2. The applications with the 2 fractions are maximized in this scenario, which makes this scenario profitable, but also expensive and risky. Next to making pellets from the dry fraction, now also paper can be made from it. End products of the wet fractions do not only contain animal feed in this scenario, but also human food, bioplastics, glue, pharmaceuticals and other chemical compounds. All applications are included in Figure 9.

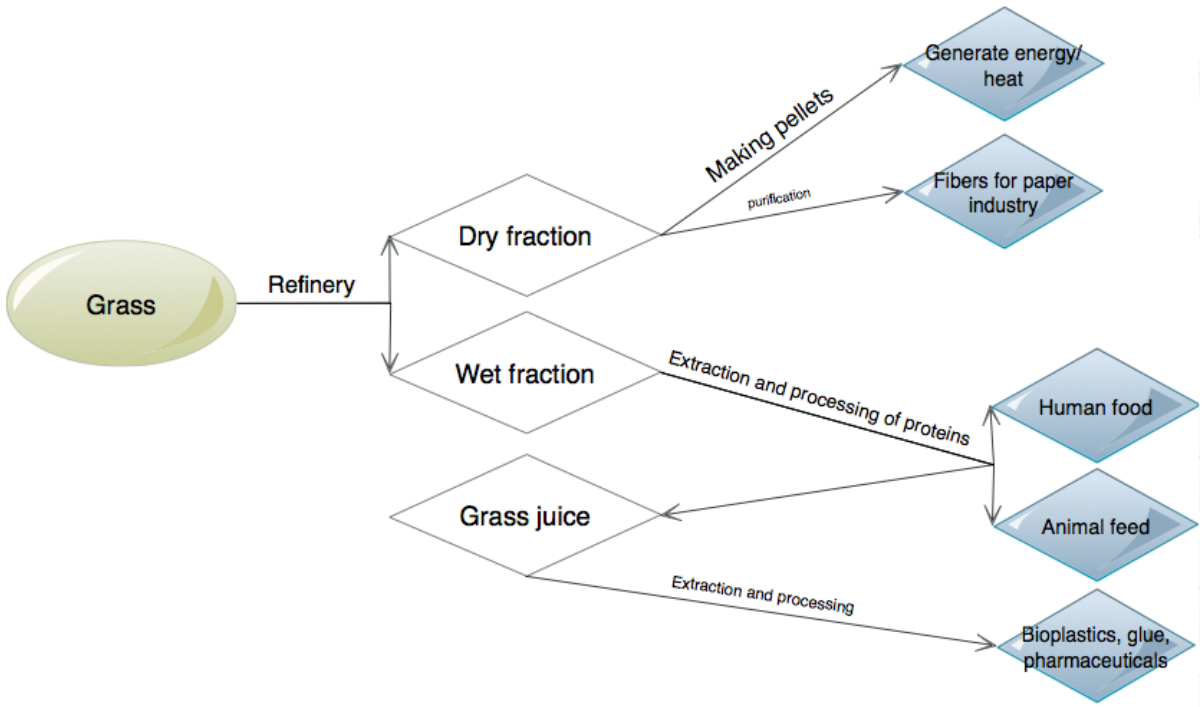


Figure 9 Complex grass refinery in block scheme.

5.4.2 Conditions

The complex scenario needs more cooperation, more machines, bigger investments and it has more uncertainties. In this example the dry fraction is used to produce either pellets or use the fibers in the paper industry. The paper industry can mix grass fibers into their production process instead of using wood fibers. Cooperation with a paper company is needed.

The wet fraction is used to make protein rich animal feed, but the same protein mixture can also be used to make human food. This business is still in its infancy and researched by NIZO food. Probably it is rather complex (more complex than the other processes). The grass juice that is left over is a mixture of water and other chemicals. These chemicals can be extracted and are raw materials for the production of bioplastics, glue and eventually pharmaceuticals. An example is the extraction of lactic acid. These processes can be seen as complex and partners from outside Drenthe may be needed. Both lactic acid and lignin can be used for a large amount of applications, so the amount of end products is high.

This scenario consists of a lot of steps, to start with fractioning of liquids and solids. The solids are compressed into pellets or treated for production of paper. The liquid fraction has to be separated into different compounds: protein, acids and lignin. All these compounds have different conversion steps and need different treatments. To use the end product from the wet fraction are the extracted chemicals. To be able to use these chemicals they still need to be converted into usable products. Concluding you may say that the complex refinery scenario indeed consists of a complex system with

a lot of different steps. Knowledge about complex processes is needed for this scenario, especially for the conversion steps of the liquid fraction. Extracting lignin and acids is a high-tech process and it is important that a coordinator understands the dangers and methods of this process. Extra research needs to be done, mostly about the lignin and acids extracted from the biomass. Some extraction methods for these chemicals are tested and found reliable, but this does not account for all the methods. When the chemicals are extracted the process is not done yet, because the lignin still needs to be converted into actually usable material.
About the actual use of those chemicals more research needs to be done. Several applications are known, but little of these are already in use. There are quite some safety regulations concerning this scenario. Working with acidic and basic chemicals, high temperatures, complex machinery make safety measures necessary. Scenario 4 has many end products, for example human food and pharmaceuticals. For human food and pharmaceuticals very strict regulations apply, the food and pharmaceuticals from extracted compounds from grass need to be tested to be sure that they can safely be used. Therefore also extra research is needed. The research as well as the needed infrastructure will need a considerable investment, which makes this scenario the riskiest of all. It is not sure whether the research and built infrastructure will lead to a profitable and sustainable grass reuse system.
To meet the requirements of regulations and to set up a process with lots of steps like in this scenario much cooperation is needed. Moreover it will take time before this scenario can be applied. These factors also make this scenario risky. Even after a period of investment and consultation the development could cease. However, if this scenario would become a success, the profit could be considerable as well as the saving of resources. Some possible end products would be on the highest level of the biomass valorization pyramid, which means that the added value of the grass would be high. However it is questionable whether Southwest Drenthe is the right place to undertake such risks.

5.5 Scenario 5: Pellets and Fermentation

5.5.1 Process

Next to the grass refinery scenarios, there is also the option to reuse grass directly without the step to separate the dry and the wet fraction of the grass. Pellets can be made out of the grass, which can be burned for heat or energy. This can be done by making use of a press machine. Another direct application of grass can be dry fermentation. Dry fermentation is done in a digester. Soil fertilizer and biogas are produced by the fermentation. The fertilizer forms a compact fraction on that is left over after fermentation, while the gas is produced during the fermentation process. The gas can be collected at the top of the digester. When taking a look at the processes in Figure 10 it becomes clear that this scenario is less complex than the biorefinery scenarios.

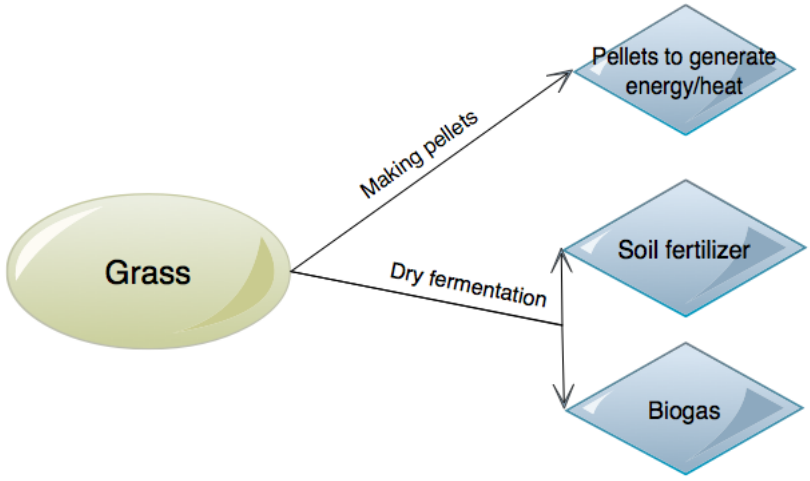


Figure 10 Direct application in block scheme.

5.5.2 Conditions

Probably the criteria of this scenario are best comparable to simple biorefinery. An advantage is that, compared to simple biorefinery, for direct reuse less process steps are needed. Also less knowledge is needed, less research is needed and less safety measures have to be taken. Less cooperation is needed and the application term is shorter than for simple biorefinery. Since mainly energy and fuels will be produced the direct scenario will be on a lower level in the biomass valorization pyramid. Compared to simple biorefinery the regulations will be about the same and risk, investment and resources savings will be lower.

6 Multi Criteria Analysis

In the previous chapter 5 different scenarios were illustrated. These are the five different scenarios we presented to our client and the entrepreneurs on June 9th 2015 in Ruinerwolde, see Appendix C.iv. For the multi criteria analysis the five scenarios are rated on 12 criteria we determined based on requirements and possibilities of the scenario's. After presenting our scenarios we handed out questionnaires to our client and the entrepreneurs. These questionnaires were based on the 12 criteria which should be given a score from 1 to 6. 1 meaning easy/simple things and a value of 6 meaning complex things, this will be explained in Chapter 6.1. After scoring the criteria the entrepreneurs were also asked to rank the criteria with regard to importance, 1 being very important and 6 being least important. We chose a scale from 1 to 6 to prevent entrepreneurs from sticking to the middle rating in case of irresolution, which could be the case if we chose an odd number. After analyzing the questionnaires we could conclude which scenario, according to us, suited a specific entrepreneur best. To do this we ourselves rated the different criteria for each scenario. For the exact methodology of the Multi-criteria analysis, see Chapter 2.1.3.

6.1 Criteria

In this section the criteria of the MCA will be clarified. Stakeholders assigned a rating in the range of 1 till 6 for each criterion. For each criterion the meaning of values 1 and 6 will be given.

1. **Possibilities with end product(s)**: the combination of conversion processes of grass differs in each scenario, so each scenario will result in a different combination of end products. The stakeholders are asked to choose for 1 end product (value 1), or more than 10 (value 6) end products or something in between. The compost scenario would lead to 1 end product, while the several biorefinery scenarios could lead to more than 2 or even more than 10 end products. The amount of end products can serve as an indicator for the complexity of the process. The more advanced the process, the more compounds can be extracted from the grass.
2. **Amount of process steps**: this criterion is also an indicator for the complexity of the process. If stakeholders are willing to apply processes with lots of process steps they are likely able to facilitate complex processes. Value 1 was assigned to a process with 1 step; value 6 was assigned to a process with a lot of steps. As we were not fully aware of the amount of steps in each process we did not define what 'a lot of steps' means.
3. **Knowledge needed**: to set up a biorefinery more knowledge is needed than for composting. Value 1 was defined as having minimal knowledge; value 6 was defined as having a sufficient knowledge about scientific developments regarding biomass waste reuse.
4. **Further research needed**: several scenarios we designed encompass process steps that are still being developed and are scarcely applied at the moment. Stakeholders must realize that some techniques need to be researched further before they can be applied in Southwest Drenthe. Also the grass composition can be researched for the biorefinery to be as efficient as possible. This criterion will make clear whether stakeholders are willing to and able to do further research, with value 1 referring to little research and value 6 referring to a lot of research.
5. **Safety**: basically the more complex the scenario, the more safety measures will have to be taken. We did not specifically examine safety issues, but for more complex scenarios larger machines need to be applied and more chemical substances are used, so we thought stakeholders should be aware of safety measures that possibly will have to be taken. Value 1 was assigned to 'no safety issues'; value 6 was assigned to 'several safety measures'.
6. **Regulations**: there are several regulations that have to be taken into account, for example regarding soil fertilizer use and grass mowing. The amount of regulations for , for example, human food are much stricter than for animal food, but animal food is restricted by more rules than compost. These regulations influence the scenarios. Value 1 indicates that

stakeholders can only subject to basic regulations, while value 6 indicates that stakeholders are able to cope with lots of regulations.

7. **Cooperation**: extensive projects will in most cases need more cooperation to succeed than smaller projects. The willingness to cooperate indicates how complex the grass reuse projects can be in Southwest Drenthe. Value 1 means that a stakeholder wants to work individually; value 6 means that stakeholders want to work together with a considerable amount of other stakeholders.
8. **Application term**: in this criterion is defined whether scenarios can be applied on short-term or long-term. Value 1 is given to projects that can be applied immediately, like composting. Value 6 is given to scenarios that will only lead to profit after a long period of research, preparation and investment, like complex biorefinery.
9. **Level in the biomass valorization pyramid**: this criterion indicates what the interest of the stakeholders is. The higher the stakeholders want to go in the biomass valorization model (Figure 1), probably the more economic interest they have. It also indicates the ability of a stakeholder to invest in and to research a complex scenario. Value 1 means the bottom of the pyramid, values 2 and 3 mean the second lowest level of the pyramid, values 4 and 5 mean the second highest level and value 6 means the highest level of the pyramid.
10. **Risk**: scenarios that need further research and are applied on a long term have a smaller chance to succeed. However, the economic potential is larger. Stakeholders that are not willing to take a risk apply value 1 to this criterion, while stakeholders that want to take risks apply a higher rating.
11. **Investment of money**: complex scenarios need more investment of money than less complex scenarios. Value 1 indicates willingness to only invest a small amount of money, while value 6 indicates willingness to invest large amounts of money.
12. **Resources savings**: in some scenarios using grass clippings can save natural resources, for example when producing paper wood is saved and when producing lactic acid expensive saccharides are saved. So this criterion indicates sustainable as well as economic interest. Value 1 was defined as 'replacing no resources' and value 6 was defined as 'replacing several finite resources'.

We rated the five scenarios on the above-mentioned criteria. Because there are five different scenarios we gave the criteria a score from 1 to 5. The meaning of low and high values is the same as for the 1 to 6 rating scale that the entrepreneurs use. The results of our scores for the different criteria per scenario are shown in Table 3.

Table 3 Our scores per criteria for the different scenarios .

Criteria	Compost	Simple	Medium	Complex	Direct
Possibilities end product	1	2	4	5	3
Amount of steps	1	3	4	5	2
Knowledge	1	3	4	5	2
Research	1	3	4	5	2
Safety	1	3	4	5	2
Regulations	1	3	3	5	3
Cooperation	1	3	4	5	2
Application terms	1	3	4	5	2
Level in the pyramid	3	4	4	5	2
Risk	1	3	4	5	2
Investment	1	3	4	5	2
Resource savings	1	3	4	5	2

Most of the results can be explained by the previous chapter where all the scenarios are illustrated. However, some scores should be explained more in detail. Making a distinction between the amounts of rules was difficult, which is why we decided to divide the regulations in three different stages instead of five. The score of 1 was given to compost, for which only some rules apply to the end product. The end products for the simple biorefinery, the middle biorefinery and the direct scenario can all be used for animal food production, which is why we scored these all a 3. For the complex biorefinery scenario the end product can also be used for human food, which is restricted with much more rules than the animal food which is why we scored it a 5.

The biomass valorization pyramid (as shown in Figure 1) only consists of 4 different stages, which is why only values from 2 to 1 could be filled in. A score of 1 for the valorization pyramid would have meant that nothing was done with the grass, but as this was not part of any of our scenarios this score was not given.

To link the filled in questionnaire with the most fitting scenario we created an excel model which provided us with the needed information. In Figure 11 a print screen of the used excel model can be seen. This is an example of the compost scenario with the values of one of our stakeholders.

Criteria	Value Research	Priority Stakeholder	Value Stakeholder	Normelized Priority	Points Scenario	Points Stakeholders
Possibilities end product	1,2	6	6	0,113207547	0,135849057	0,679245283
Amount of steps	1,2	1	3	0,018867925	0,022641509	0,056603774
Knowledge	1,2	4	4	0,075471698	0,090566038	0,301886792
Research	1,2	4	6	0,075471698	0,090566038	0,452830189
Safety	1,2	6	4	0,113207547	0,135849057	0,452830189
Regulations	1,2	1	3	0,018867925	0,022641509	0,056603774
Cooperation	1,2	6	6	0,113207547	0,135849057	0,679245283
Application terms	1,2	6	1	0,113207547	0,135849057	0,113207547
Level in the pyramid	3,6	4	2	0,075471698	0,271698113	0,150943396
Risk	1,2	6	1	0,113207547	0,135849057	0,113207547
Investment	1,2	4	4	0,075471698	0,090566038	0,301886792
Resource savings	1,2	5	5	0,094339623	0,113207547	0,471698113
Total amount of points		53		1	1,381132075	3,830188679
						2,449056604

Figure 11 Example of the excel model used to find the most fitting scenario per filled in questionnaire.

The Value Research is the value we gave the criteria per scenario based on the literature we found, as can be seen in Table 3. The Priority Stakeholder is the priority given by the stakeholder on the filled in questionnaire. This value has been normalized so that the total of all the given priorities is 1. The value of the stakeholder is the value given by the stakeholder on the filled in questionnaire. The Value Research multiplied by the Normalized Priority gives us Points scenario based on the literature and how important a stakeholder finds certain criteria. The Value Stakeholder multiplied by the Normalized Priority gives us Points stakeholders, these are the wanted points for all the criteria combined. Comparing Points stakeholders with Points scenarios gives a number; the difference. The smallest difference between the points of a scenario and the wanted amount of points gives the most fitting scenario per questionnaire. The values we gave the criteria per scenario are on a range from 1 to 5, but the values given by the stakeholders on the different criteria are scored 1 to 6. To be able to compare these values we converted the 1 to 5 scale used for the scoring of the criteria based on literature, to a 1 to 6 scale used for the scoring of the stakeholders, by multiplying with 6 and then dividing by 5.

6.2 Results

The results of the Multi Criteria Analysis on the different scenarios is shown in Figure 12. 15 entrepreneurs filled in the questionnaire, see Appendix B.

The data of the filled in questionnaires are analyzed with the Excel model and per questionnaire a n outcome is calculated which is than matched with a specific scenario. The results are shown in Figure 12. As can be seen 10 questionnaires matched with the simple biorefinery scenario, 3 questionnaires matched with the medium biorefinery scenario and 3 questionnaire matched with the direct processing of grass scenario. Composting, which is actually the used scenario in Drenthe at the moment is not wanted, which means that a change is needed. Most stakeholders are interested in the simple biorefinery and a few are most interested in the medium biorefinery and the direct use of grass. Most stakeholders are interested in the simple scenario, but a few do want to go further. As can be seen from the results none of the stakeholders want to go as far as complex biorefinery.

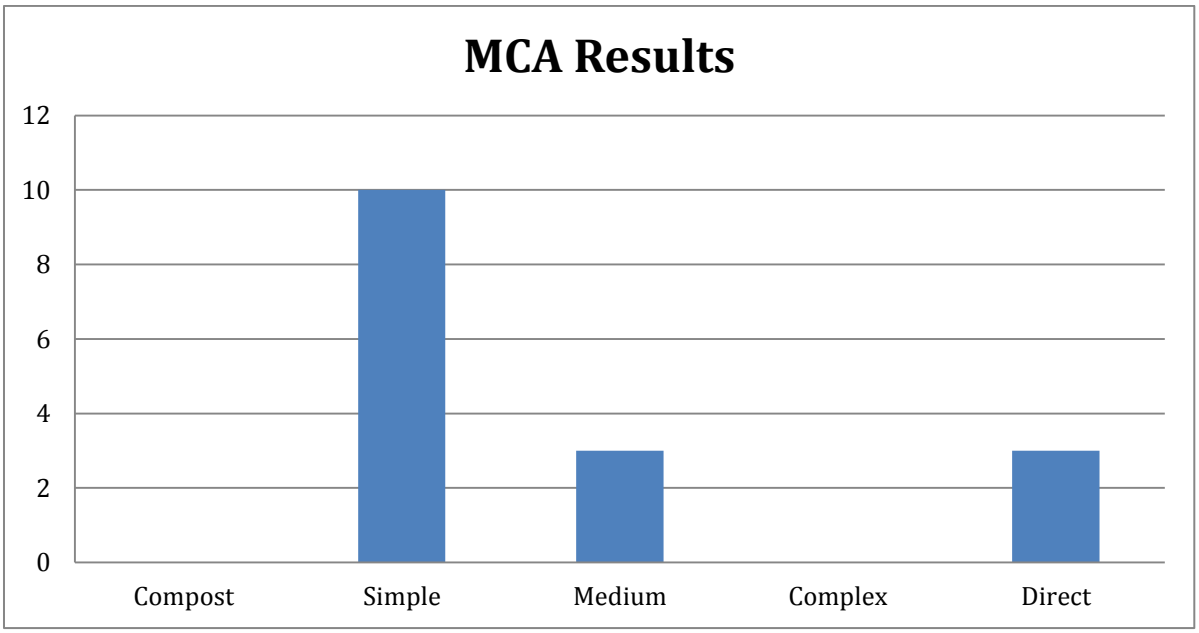


Figure 12 Results MCA per scenario.

In Table 4 the averages of the priorities and values given by the stakeholder are shown. High priorities are given to cooperation, risk, investment and safety with priorities of 1.9, 2.4, 2.6 and 2.7 respectively. Low priorities are given to the level in the pyramid (3.4) and resources savings (3.9). High values are given to cooperation, research, resource savings and the possibilities with the end product with values given of 4.9, 4.5, 4.5 and 4.4 respectively. Low values are given to risk, regulations, investment and amount of process steps, respectively values of 2.5, 3.1, 3.2 and 3.3 are given.

Table 4 The average results of the MCA per criteria.

Criteria	Priority Stakeholder	Value Stakeholder
Possibilities end product	3.3	4.4
Amount of steps	3.3	3.3
Knowledge	3.3	3.7
Research	3.3	4.5
Safety	2.7	3.7
Regulations	3.1	3.1
Cooperation	1.9	4.9
Application terms	3.3	3.8
Level in the pyramid	3.4	3.9
Risk	2.4	2.5
Investment	2.6	3.2
Resource savings	3.9	4.5

7 Discussion

This section we will discuss our research process, the limitation in our research and our multi criteria analysis.

7.1 Limitations

Every research performed will have its limitations. Situations set boundaries during the researching process that may affect the results. First of all we have limited knowledge. For us as students, we are still developing the required knowledge to perform a good research. We also don't have enough knowledge on finances or investments in technology so therefore no financial conclusions or assumptions can be drawn from our analysis.
Secondly the limits in our resources also play a role. We did not do research on site with experiments. So our findings are based on theoretical knowledge and secondary empirical research. In practice a lot of other factors (e.g. financial, political) play a role that can obstruct the application of a certain technology. The data we used (including the literature) is also secondary data and we will try our best to choose the most reliable sources. This also brings us to the next section.

7.2 Research

Our research question is now stated so that we did not need to perform a MCA, but we wanted to know what the most valued question was. And we cannot change our research question after our research. But with this MCA we get an impression what for the stakeholders in Drenthe the most valued options is.
Secondly, our research is mainly based on literature. The finding of literature may contain biases. What a person finds on a subject may differ from what another person finds on that same subject. This may happen for example due to different search queries or different vocabulary.
Which literature we find is also based on our search queries and may not use all possible search words. What also is a limitation is that not all articles were available.

7.3 Multi Criteria Analysis

To decide which scenario fits the best in Southwest Drenthe, we did a MCA. We set up a number of criteria. Per scenario we ranked the criteria as 'experts'. Because most of this data we could not find in literature we made a ranking on logic and outcomes of ranking from other criteria than literature. There can also some comments made on the workshop with the stakeholders. The stakeholders could give a ranking on every criteria. We explained the extreme outcomes of the criteria . The explanation on what we understand on 'much' and 'few' was still most of the time without an exact number. It could be vague. We try to solve this by explaining the extremes with examples from the scenarios. Still there could be a difference on how people understand the criteria.
Another remark is that during that the stakeholders where filling the questionnaire of the MCA, some stakeholders were discussing what to fill in per criteria. This can be found back in some questionnaires, you can see that the questionnaires are identical to each other.
Companies that are present with multiple representatives can have an advantage by doing this. Their results weight heavier in the end result of the MCA. The question could be raised if it is valid to use the MCA like this. It could happened that small companies with a lot of representatives present at the meeting get a bigger influence than big, more important, companies. On the other hand it is questionable if bigger companies should also get bigger influence.
More comments can be placed on how the MCA is performed. The six-point scale we worked with could be interpreted differently by every user. In other words, some people always fill in the extremes others stay close to the center. The distance between one point and a second point could also be interpreted in another way. The MCA performed in this study was rather simplified, overall it might be better to use it as a guideline for further discussion but not take the results as direct advice.

8 Conclusion

Samenwerkingsverband De Wolden-Hoogeveen has been looking for innovative ways to reuse grass clippings. There are lots of technologies that can be applied to grass to produce value-added products. However, current research is pointed mainly at using single components of grass, while this paper tries to find out whether all capabilities of grass can be utilized, even after one component has already been extracted. Especially biorefinery provides an interesting possibility to maximize the added value of grass, as in the case of biorefinery grass is separated into a wet and a dry fraction. The wet and dry fraction all give way to different processes that use the different fractions of the grass.

First we looked at treatments available to retrieve valuable chemicals from the wet fraction. Out of our literature research we found that the extraction of lignin, protein and acid from grass were the most interesting to pursue.
Lignin: Lignin can be extracted from the wet fraction from grass pressing. By heating it up and adding chemicals. The processes investigated processes include: the Kraft process, sulphite pumping and organosulf.
Proteins: Proteins can be extracted by pressing the grass and then adding lactic acid to the grass juice. Heating this mixture will make the protein cluster up with the lactic acid. By filtering the liquid the protein can be retrieved.
Acid: Adding enzymes to the wet fraction of the grass breaks down the complex sugar molecules to glucose. During this process the lactic acid bacteria will produce lactic acid.

We subsequently investigated how the remaining dry fraction could be used. As we expected soil fertilizer and fuel are possible end products, however also paper can possibly be produced from the dry grass fraction.

Although after finding out the possibilities with grass clippings we already reached the goal of our research, we felt the entrepreneurs needed more support. To provide a coherent way to present an overview of the possibilities and technologies regarding grass use, a division in scenarios turned out to be sufficient. Further division into criteria gave the opportunity to find out which scenarios were best applicable to Southwest Drenthe. The entrepreneurs in Southwest Drenthe were clearly ambitious and wanted to use grass for more than just compost. As became clear from the MCA simple to medium biorefinery is the most favored scenario in Southwest Drenthe.

By doing the MCA the entrepreneurs had to fill in a questionnaire, which helped them to get a clearer vision of the possibilities with grass waste with Drenthe. After filling in the questionnaire there was a discussion during which a start was made with a shared vision of all entrepreneurs. Probably this discussion was even more important than the options for grass use we presented, as during the discussion the entrepreneurs really started to make plans for Southwest Drenthe. They especially seemed to find the topic of grass for human consumption interesting. After the discussion the entrepreneurs and representatives from the Gebiedscoöperatie Zuidwest-Drenthe decided to initiate an investigation group, consisting of the interested entrepreneurs, to further research applicability of grass use in Southwest Drenthe. They use our findings as a basis and will look at aspects we did not investigate, like economical feasibility and legislation, to find the best option for grass reuse in Southwest Drenthe.

When we first started to find out what possibilities there are to use grass clippings, we did not expect that we could arouse the entrepreneurs' interest to such an extent that they would actually be trying to apply our findings in Southwest Drenthe. We are satisfied to have induced the discussion and that this research will possibly lay the foundations for sustainable development in Drenthe.

9 Summary

The Regional Cooperation of Southwest Drenthe facilitates biomass reuse projects to stimulate sustainability in the region. Currently they are looking at ways to use roadside grass clippings in an innovative way. The research question we developed is: What treatments can be used to retrieve chemicals from grass from the municipality of De Wolden and Hoogeveen and can the grass be used as soil fertilizer or fuel afterwards? There are different chemicals retrievable from grass. We discussed 3 main chemicals; proteins, acids and lignin. The extraction processes from these 3 chemicals are complex methods that can provide a lot of end products.

When refining grass the biomass can be split into a wet fraction and a dry fraction. About 20% of the dry fraction is protein. The protein that can be produced is edible for pigs, chickens and after extensive processing even humans.

We investigated two types of acids that can be retrieved from grass. Lactic acid and Amino acids. With lactic acid the production of biodegradable plastics is possible. Amino acids can be used in the food and feed industry as an additive and flavor.

The fibers in the dry-fraction of grass can be used to produce paper or cardboard. The necessary techniques have not been fully developed yet but using grass to produce paper is certainly a possibility.

Using grass to create pellets for combustion is also a possibility. Pellets consist of biomass, compressed into grains by machines. To have high quality pellets the grass has to be in a specific moisture range.

Aerobic composting of the grass and using it as soil amendment is a method that is already done in Drenthe at the moment. It is relatively simple and is well-known. The process of anaerobic composting is a little bit different from aerobic composting but the end product is the same.

These methods are ideally combined in scenarios in which different grass use options are used. In this report 5 scenarios are proposed and discussed. By using a Multi Criteria analysis the scenarios are linked to the preferences of the stakeholders of Southwest Drenthe. The Multi Criteria is based on values given per criteria by our stakeholders, in this way we made sure that the stakeholders got involved in the outcome of our research. From this Multi Criteria analysis we learned that the entrepreneurs in Drenthe are most interested in simple biorefinery and so this where they will continue their research on.

10 Nederlandse samenvatting: Hergebruik van grasmaaisel in Zuidwest-Drenthe

In Zuidwest-Drenthe wordt bermgras gemaaid. Niet alleen het maaien kost geld, maar ook het weghalen van het maaisel. Op dit moment wordt het gemaaide gras beperkt gebruikt voor productie van compost, verder zijn er nog geen toepassingen. De consequentie hiervan is dat het maaien van gras enkel een kostenpost is. Gebiedscoöperatie de Wolden constateerde dat de mogelijkheden om biomassa-afval te gebruiken er wel degelijk zijn. Grasmaaisel werd door ondernemers en betrokkenen als een veelbelovende grondstof gezien om op innovatieve manier te gebruiken. Met als doel de onkosten van het maaien van gras te drukken en tegelijk de ontwikkeling van milieuvriendelijke technieken te ontwikkelen, gaan wij op zoek naar technieken om het gras zo efficiënt mogelijk te gebruiken.

10.1 Onderzoeksvragen

10.1.1 Hoofdvraag

Welke methodes zijn er om nuttige stoffen uit grasmaaisel uit Zuidwest-Drenthe te halen en kan het gras hierna gebruikt worden als brandstof of bodemverbeteraar.

Om deze vraag te beantwoorden zullen er eerst kijken naar de nuttige stoffen die gras bevat en hoe deze stoffen uit het gras gehaald kunnen worden. Daarnaast kan gras gebruikt worden als bodemverbeteraar of als brandstof, maar is dit nog mogelijk wanneer er eerst nuttige stoffen uit het gras gehaald worden die voor andere doeleinden worden gebruikt? We een aantal scenario's geschreven waarin combinaties worden gemaakt van de mogelijkheden met gras, namelijk het gebruiken van nuttige stoffen uit het gras en gebruik als bodemverbeteraar of brandstof. Het antwoord op onze hoofdvraag hebben we gevonden met behulp van 6 deelvragen, deze worden hieronder benoemd.

10.1.2 Deelvragen

- Welke bruikbare stoffen bevat gras?
- Hoe kunnen deze stoffen gewonnen worden uit het grasmaaisel?
- Zijn de benodigde behandelingen uitvoerbaar in Zuidwest-Drenthe?
- Aan welke eisen moeten brandstof en bodemverbeteraars voldoen?
- Hoe kunnen brandstof en bodemverbeteraars worden geproduceerd met de gewonnen stoffen?
- Wat is volgens de ondernemers de gewenste behandelmethode?

10.2 Verklaring van de gebruikte termen

- Grasmaaisel nu: kort gemaaid gras met afval, zand en andere planten. Het blijft 3 dagen liggen om de zaden te verwijderen.
- Grasmaaisel zoals het gewenst is: vers of gedroogd grasmaaisel, niet alleen kort gemaaid en zonder afval, zand en andere planten.
- Nuttige/bruikbare stoffen: waardevolle stoffen in gras die, eventueel via tussenstappen, omgezet kunnen worden naar chemicaliën of materiaal.
- Uitvoerbaarheid in Drenthe: voor uitvoerbaarheid in Drenthe moet de benodigde technologie niet te geavanceerd zijn en moeten de investeringen binnen 2 à 3 jaar terugverdiend zijn.
- Brandstof: deel van het gras dat gestookt kan worden voor productie van warmte.
- Bodemverbeteraar: grasresten die de vruchtbaarheid van de bodem verbeteren, o.a. in de vorm van Bokashi en compost.

10.3 Onderzoeksmethode

Voor ons onderzoek maken we gebruik van drie verschillende onderzoeksmethoden; literatuuronderzoek en verkrijgen van data door contact met stakeholders, data analyse en een multi criteria analyse (MCA).
Aan het begin van ons onderzoek zijn we aanwezig geweest bij een PechaKucha café in Ruinerwold, hier waren al onze stakeholders aanwezig en na contact met hen hebben we vastgesteld hoe de huidige situatie is en waar voor de lokale ondernemers de interesse ligt op het gebied van hergebruik van biomassa. Aan de hand van de informatie die we deze avond hebben opgedaan hebben we onze onderzoeksvragen vastgesteld en zijn we ons onderzoek begonnen over hergebruik van bermgras. Aan de hand van literatuuronderzoek hebben we vastgesteld welke mogelijkheden er zijn met het hergebruik van biomassa. Na het analyseren van de data hebben we een vijftal scenario's geschreven waarin verschillende gebruiksmethoden van bermgras worden gecombineerd. Uiteindelijk hebben we met behulp van een multi criteria analyse bepaald welke scenario's het meest interessant zijn voor de lokale ondernemers in Drenthe.

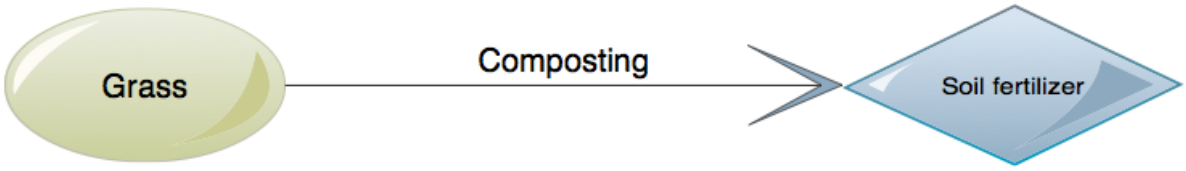
Een multi criteria analyse is een manier scenario's met elkaar te vergelijken. Van tevoren hebben we 12 criteria vastgesteld waarop de verschillende scenario's op beoordeeld zijn. Wij hebben de scenario's voor deze criteria gescoord op basis van het literatuuronderzoek wat wij hebben gedaan. Vervolgens hebben we onze stakeholders deze criteria ook laten scoren en met behulp van de multi criteria analyse hebben wij onze waarden met die van de stakeholders vergeleken. Aan de hand van deze vergelijking kan bepaald worden welk scenario het best past bij een bepaalde stakeholder.

10.4 Scenario's

Aan de hand van literatuuronderzoek hebben we 5 scenario's geschreven. Het literatuuronderzoek is niet opgenomen in de Nederlandse samenvatting omdat het achtergrondinformatie is voor het schrijven van de 5 scenario's. De scenario's zullen hier kort worden besproken.

10.4.1 Scenario 1: compost

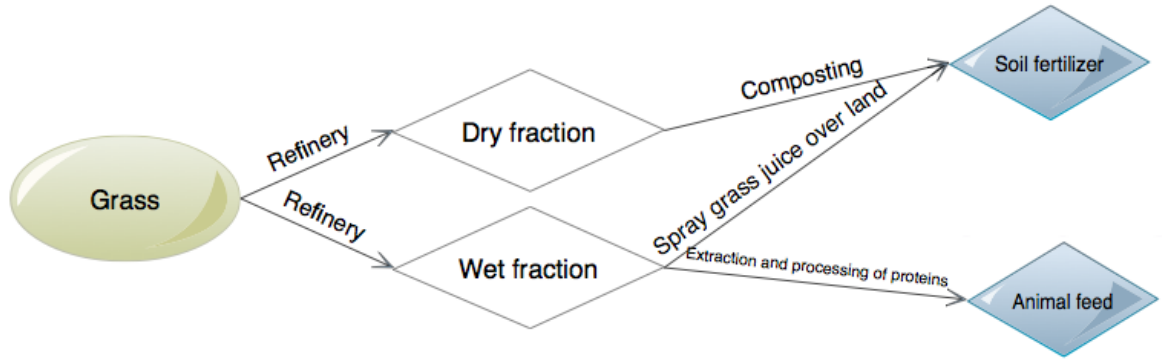
Scenario 1 is het scenario wat de huidige situatie beschrijft. Bioafval wordt gecomposteerd en gebruikt als bodemverbeteraar. Dit is een bekend proces in de wetenschappelijke wereld en naast bioafval is er verder weinig nodig om het proces te starten. In Figuur 1 is een simpel blokschema van het proces te zien.



Figuur 1 Blokschema van scenario van compost.

10.4.2 Scenario 2: simpele bioraffinage

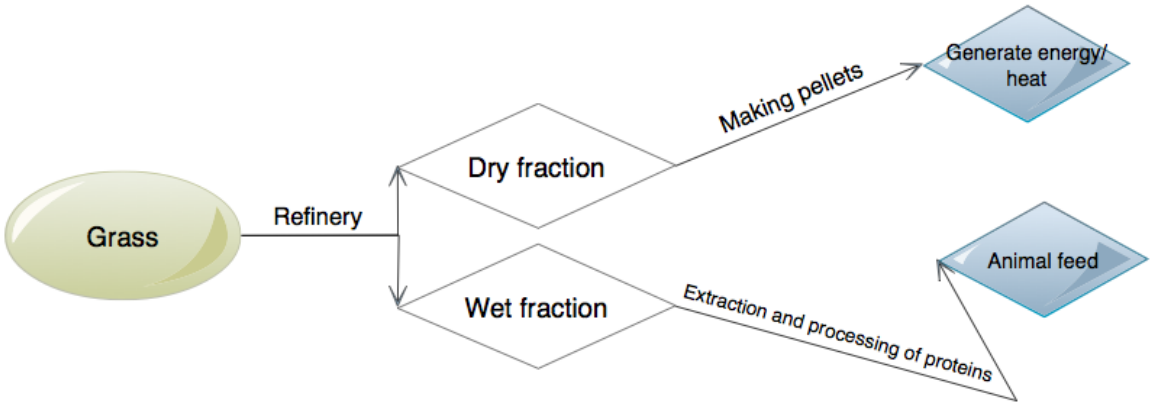
Scenario 2 beschrijft het proces van simpele bio raffinage. Met behulp van raffinage kan gras worden gesplitst in een droge en een natte fractie. De droge fractie kan gebruikt worden als bodemverbeteraar, de natte fractie kan ook gebruikt worden als bodemverbeteraar maar de natte fractie kan ook worden gebruikt voor de productie van veevoer. Met behulp van melkzuur kunnen eiwitten uit de natte fractie worden gehaald, wanneer deze eiwitten vervolgens worden gedroogd kunnen ze als veevoer worden gebruikt. In Figuur 2 is een blokschema van de simpele bio raffinage te zien.



Figuur 2 Blokschema van het scenario van simpele bioraffinage.

10.4.3 Scenario 3: middel-complexe bioraffinage

Een stap verder dan de simpele bioraffinage is de middel-complexe bioraffinage. Net als bij scenario 2 worden de natte en droge fractie gescheiden, maar het gebruik van deze fracties is nu iets anders. Uit de natte fractie kunnen, net als bij scenario 2, eiwitten worden verwijderd. De droge fractie kan door toevoeging van chemicaliën geschikt worden gemaakt voor inkuilen, de droge fractie kan ook direct worden verwerkt tot pellets. Deze pellets worden gemaakt door het gras te persen, waarna de pellets vervolgens gebruikt kunnen worden voor verbranding. In Figuur 3 is een blokschema van het bovengenoemde proces te zien.

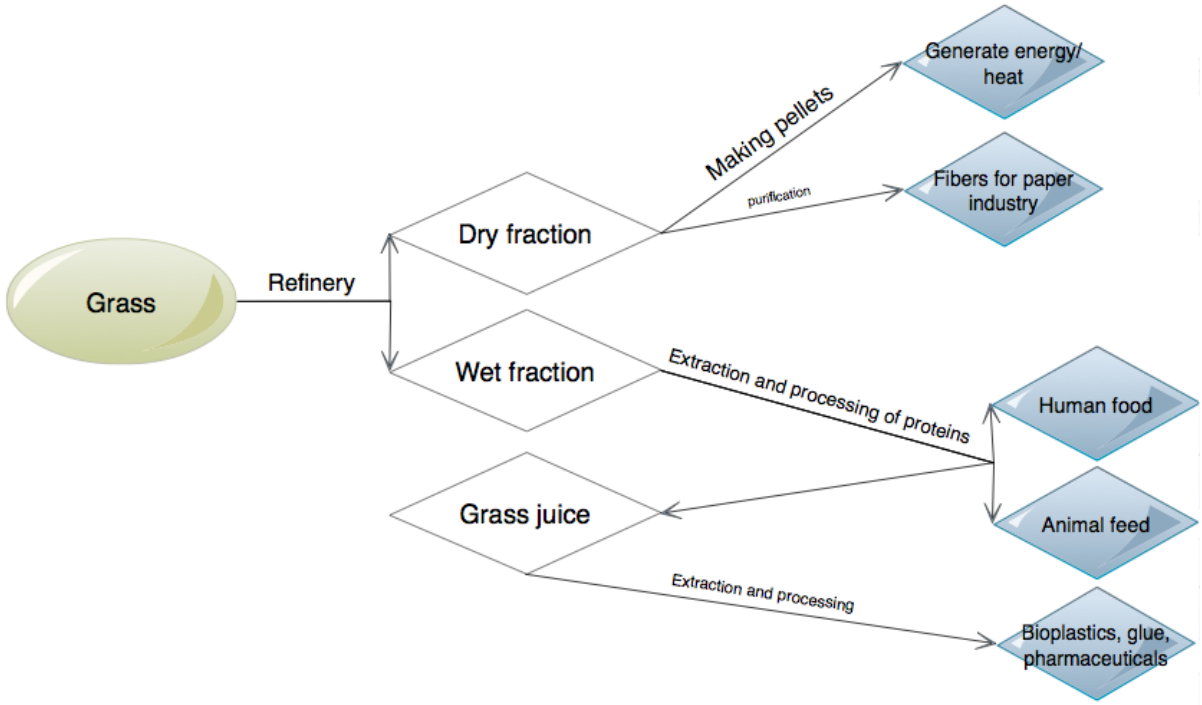


Figuur 3 Blokschema van het scenario van middel-complexe bioraffinage.

10.4.4 Scenario 4: complexe bioraffinage

Complexe bioraffinage begint weer met het scheiden van de natte en droge fractie. Het gebruik van deze twee fracties zijn in dit scenario gemaximaliseerd. De droge fractie kan gebruikt worden voor het maken van papier of het maken van pellets. De natte fractie kan worden gescheiden in verschillende chemicaliën; lignine, melkzuur en eiwitten. Lignine is een chemische stof die alle plantencellen bevatten. Lignine kan voor veel doeleinden worden gebruikt, zoals het maken van bio-plastic, lijm, maar uiteindelijk zelfs als medicijn (lignine heeft een anti-oxiderende werking). Melkzuur kan onder andere ook gebruikt worden voor het produceren van bioplastic. Eiwitten kunnen gebruikt worden voor het produceren van veevoer, maar na verwerking en aanpassing van de eiwitten kunnen ze eventueel zelfs worden gebruikt als voedsel voor de mens. In Figuur 4 is een overzicht te

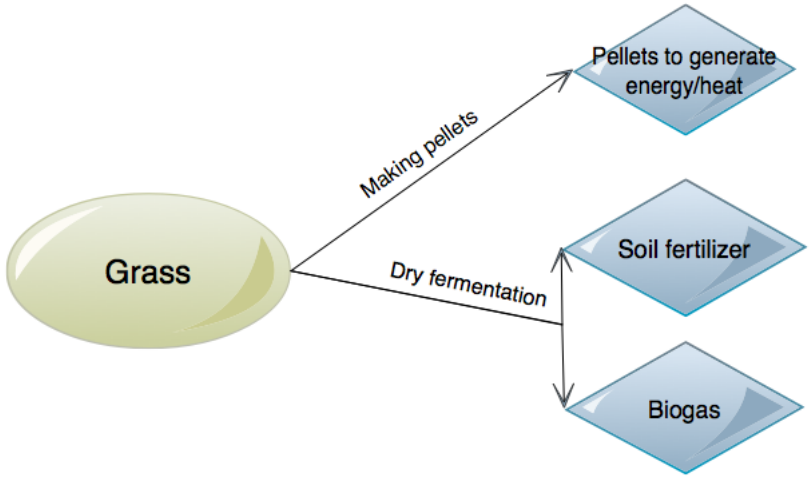
zien van complexe bioraffinage.



Figuur 4 Blokschema van het scenario van complexe bioraffinge.

10.4.5 Scenario 5: direct gebruik

Naast de verschillende opties voor bioraffinage bestaat er ook de optie om het gras direct gebruiken zonder het eerst te scheiden in een natte en droge fractie. Pellets kunnen direct van gras gemaakt worden, waarna ze verbrand kunnen worden voor warmt. Via droge vergisting kan biogas of bodemverbeteraar worden gemaakt. Voor een visualisatie van dit proces, zie Figuur 5.

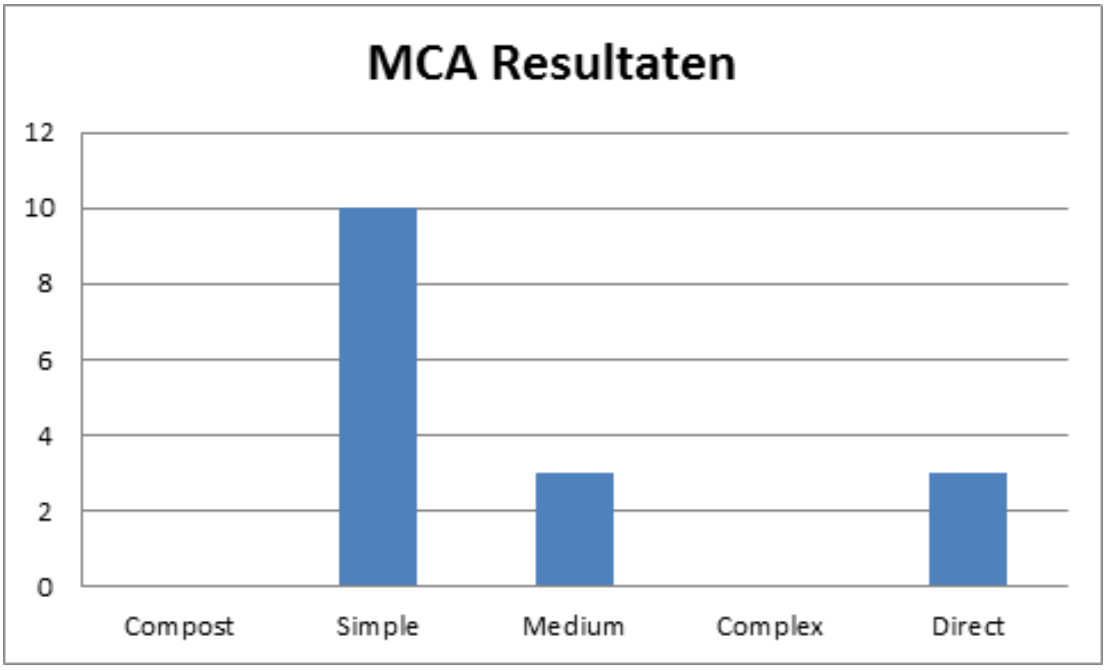


Figuur 5 Blokschema van het scenario van direct gebruik.

10.5 Multi Criteria Analyse

Aan de hand van 12 criteria hebben we de stakeholders een vragenlijst in laten vullen. Hier moesten ze een waarde geven aan deze criteria. De volgende criteria staan op deze vragenlijst: mogelijkheden

eindproduct, aantal stappen, kennis, onderzoek, veiligheid, regels, samenwerking, toepassingstermijn, hoogte in piramide, risico, investering van geld, besparing. Wij hebben deze criteria ook een score gegeven en aan de hand van een vergelijking van onze waarden met de waarden van de stakeholders kan worden bepaald welk scenario het beste past bij een bepaalde stakeholder. De prioriteit per criteria als bepaald door de stakeholder is hierin ook verwerkt. In figuur 6 is een overzicht per scenario te zien van de uitkomst van de multi criteria analyse.



Figuur 6 Resultaten MCA per scenario.

Zoals zichtbaar in de figuur wordt er door geen enkele stakeholder de voorkeur gegeven aan scenario 1, composteren. 10 stakeholders zijn met behulp van de multi criteria analyse gelinkt aan scenario 2; simpele bioraffinage, 3 stakeholders zijn gematcht met middel-complexe bioraffinage. En voor direct gebruikt bleken 3 personen voorkeur te hebben.

Tabel 1 Gemiddelde waarden en prioriteit gegeven door de stakeholder per criteria.

Criteria	Prioriteit Stakeholder	Waarde Stakeholder
Mogelijkheden eindproduct	3.3	4.4
Aantal stappen	3.3	3.3
Kennis	3.3	3.7
Onderzoek	3.3	4.5
Veiligheid	2.7	3.7
Regels	3.1	3.1
Samenwerking	1.9	4.9
Toepassingstermijn	3.3	3.8
Hoogte in piramide	3.4	3.9
Risico	2.4	2.5
Investering van geld	2.6	3.2
Besparing	3.9	4.5

Zoals zichtbaar in Tabel 1 hebben vooral samenwerking, risico, investering van geld en veiligheid een hoge prioriteit, respectievelijk werden de volgende scores gegeven; 1.9, 2.4, 2.6 en 2.7. Lage

prioriteiten worden onder andere toegekend aan besparing van grondstoffen (3.9) en hoogte in de piramide (3.4).
In Tabel 1 zijn ook de waarden toegekend per scenario zichtbaar. Vooral risico (2.5) en regels (3.1) scoren hierbij laag. Besparing (4.5), onderzoek (4.5) en samenwerking (4.9) scoren erg hoog.

10.6 Conclusie

Onze onderzoeksvraag was: Welke methodes zijn er om nuttige stoffen uit grasmaaisel uit Zuidwest-Drenthe te halen en kan het gras hierna gebruikt worden als brandstof of bodemverbeteraar?

Het antwoord op deze vraag kan opgedeeld worden in twee delen. Als antwoord op het eerste deel van de hoofdvraag kan worden gezegd dat er meerdere behandelingen en methoden zijn die gebuikt kunnen worden voor het extraheren van nuttige stoffen uit gras. Afhankelijk van welke stoffen er uit gras gehaald worden kan er nog brandstof, bodemverbeteraar of pellets van gemaakt worden. In dit rapport hebben we ons gefocust op bioraffinage, de eindproducten van bioraffinage verschillen van hoogwaardige chemicaliën tot compost en brandstof.

De multi criteria analyse maakt duidelijk dat er zeker kansen zijn om de voorgestelde scenario's waarheid te maken. Het is aan de stakeholders om te bepalen welke richting ze nu precies in gaan. Gebaseerd op de resultaten van de multi criteria analyse en de discussie in Drenthe kunnen we concluderen dat de voorkeur ligt bij simpele of middel-complexe bioraffinage. Wanneer een concreet scenario wordt gekozen is het belangrijk dat hier meer onderzoek naar wordt gedaan.

10.7 Discussie

10.7.1 Beperkingen

Om te voorkomen dat we te veel gaan bespreken, hebben we voor het onderzoek een aantal beperkingen geïdentificeerd. Om te beginnen zijn we studenten, niet een consultancybureau. De bijdrage die we kunnen leveren is beperkt en wordt grotendeels bepaald door de hoeveelheid tijd we hebben. Daarnaast kunnen we niet garanderen dat het advies dat voortkomt uit ons onderzoek leidt tot de resultaten zoals die worden voorgesteld in het verslag. Verder is onze bijdrage met name wetenschappelijk; over zaken als de toepasbaarheid in Drenthe en de economische aspecten kunnen we enkel indicaties geven. Tenslotte werken we in opdracht van zowel de universiteit als de gemeente Hoogeveen. Beide partijen hebben hun eisen (o.a. over de taal waarin het verslag geschreven dient te worden), we proberen hierin een middenweg te vinden die zo goed mogelijk bij de wensen van beide partijen past. Het kan zijn dat we niet aan bepaalde eisen van een van de partijen kunnen voldoen.

10.7.2 Literatuuronderzoek

Ons onderzoek is voornamelijk gebaseerd op literatuuronderzoek. Onze bevindingen kunnen gebaseerd zijn op vooroordelen, wat de ene persoon van een bepaald onderwerp vind kan verschillen van wat een andere persoon hiervan vind. Welke literatuur we vinden is bepaald door onze zoektermen, hierdoor worden wellicht niet alle mogelijkheden gevonden. Sommige artikelen waren niet beschikbaar voor ons, wat ons onderzoek ook limiteerde.

10.7.3 Multi-criteria analyse

Om te bepalen welk scenario het beste past in Zuidwest Drenthe hebben we een MCA gedaan. Deze MCA is gebaseerd op een aantal criteria. Deze zijn door ons beoordeeld, maar omdat we veel van de gewenste data voor het beoordelen van deze criteria niet konden vinden in literatuur hebben we een deel gebaseerd op onze eigen logica.

De criteria konden beoordeeld worden van ‘weinig’ naar ‘veel’, er zaten geen direct getallen verbonden aan deze waarden wat het lastig maakt om onderscheid te maken. Zoals eerder gezegd verschilt per persoon de perceptie van deze waarden. We hebben geprobeerd dit probleem op te lossen door zo goed mogelijk de criteria toe te lichten met voorbeelden, het kan echter wel goed zijn dat er hierdoor verschillen in waardering per persoon zitten.
Tijdens het afnemen van de vragen door middel van de vragenlijst zaten vrijwel alle stakeholders in hetzelfde lokaal. Hierdoor is er het een en ander overlegd tussen verschillende partijen, wat de uitkomst van de vragenlijst beïnvloed kan hebben. Enkele mensen hebben de vragenlijst zelfs volledig samen ingevuld.
Een ander probleem waar we tegenaan zijn gelopen is de hoeveelheid personen dat een bepaald bedrijf representeert. Wanneer meerdere mensen van een klein bedrijf aanwezig zijn en maar weinig mensen van een groter bedrijf dan heeft het kleine bedrijf meer invloed vanwege het invullen van meer vragenlijsten, maar uiteindelijk zou dit kleine bedrijf misschien juist wel minder invloed moeten hebben.

11 Societal Evaluation

Due to the many stakeholders involved (including Samenwerkingsverband De Wolden Hoogeveen) in our project we knew instantly that we had a policy-orientated research. But we did in the beginning of the project not really understand what the problem was in Drenthe. Drenthe has biowaste and they compost it which is already a relatively sustainable solution. So why would Drenthe want to do something more “sustainable” and innovative with the biowaste from grass clippings etc. The word sustainable was used repeatedly but doing something else with biowaste instead of composting is not by definition more sustainable. So if we want to be more objective, before saying let’s do something more sustainable than composting one must first research how sustainable composting is. This limits the chance for the subjective normative assumptions to be wrong. The way we as researchers see the situation is: Drenthe is looking for alternatives to treat biowaste and not necessarily more sustainable alternatives.

It’s also funny to recognize the fact years ago, composting biowaste and using it as soil amendments was an innovative solution that was technologically sustainable. But technology developed, and so did the people’s perception of what is innovative. This is a nice example of how technology is morally relevant in everyday situations. The question now is, how long does it take before these new innovative ideas and projects become old and “normal’?

What we overlooked in the beginning was the social sustainable aspect of the project: uniting entrepreneurs and offering new (job) opportunities for inhabitants of southwest Drenthe. Possibly blooming and expanding the local economy. However this is assuming all goes well during the application of the innovative use of grass biowaste. It is also possible that plans do not work out, that entrepreneurs lose money due to bad investments and that the relationship between government officials and entrepreneurs may get damaged. This may cause a rise in distrust from inhabitants towards the municipality.

The commissioner first wanted to get as much chemicals as possible from the grass waste. Aided by our scientific background we made an inference, concluding that it is not feasible (yet) for Drenthe to have high tech technological biowaste treatment facilities. However, ethically speaking the intuitive judgements from laypeople should not be dismissed. So in order to keep our client content and to do our job as scientists simultaneously we tried combining our view with the vision of the commissioner. We decided to let them perform an MCA with a few options we worked out.
During the last meeting when the stakeholders all sat down to perform the MCA, it was evident that there were 2 major groups in the room. The government on one side and the other the entrepreneurs (and business owners etc.). Within the entrepreneurs there was also a sense of hierarchy. It seemed as if some of them were more impactful with their statements, and most of the time their peers agreed with them.

Within the government, the “power” was more equal distributed except for the hosts. After all they facilitate the project. They also made the decision to choose grass as the option in a previous meeting, we and the stakeholders were going to focus on.

There was a clear tension between the 2 groups. It was as if they already had previous experiences with projects that went wrong. Some were more vocal than others when expressing their concerns. The concerns were mostly about rules and regulations within the law-system.

Table 5 The matrix with stakeholders Southwest Drenthe.

Respect for:	**Sustainability**	**Autonomy**	**…….**
Government	The government officials want sustainability in the social aspect. Creating jobs and opportunities in Drenthe. Also a little bit environmental sustainability	The government parties would prefer everybody to work together	
Entrepreneurs	The entrepreneurs are more concerned about their financial and economical sustainability. Also a little bit environmental sustainability	The entrepreneurs do not mind working together, as long as they make profit	

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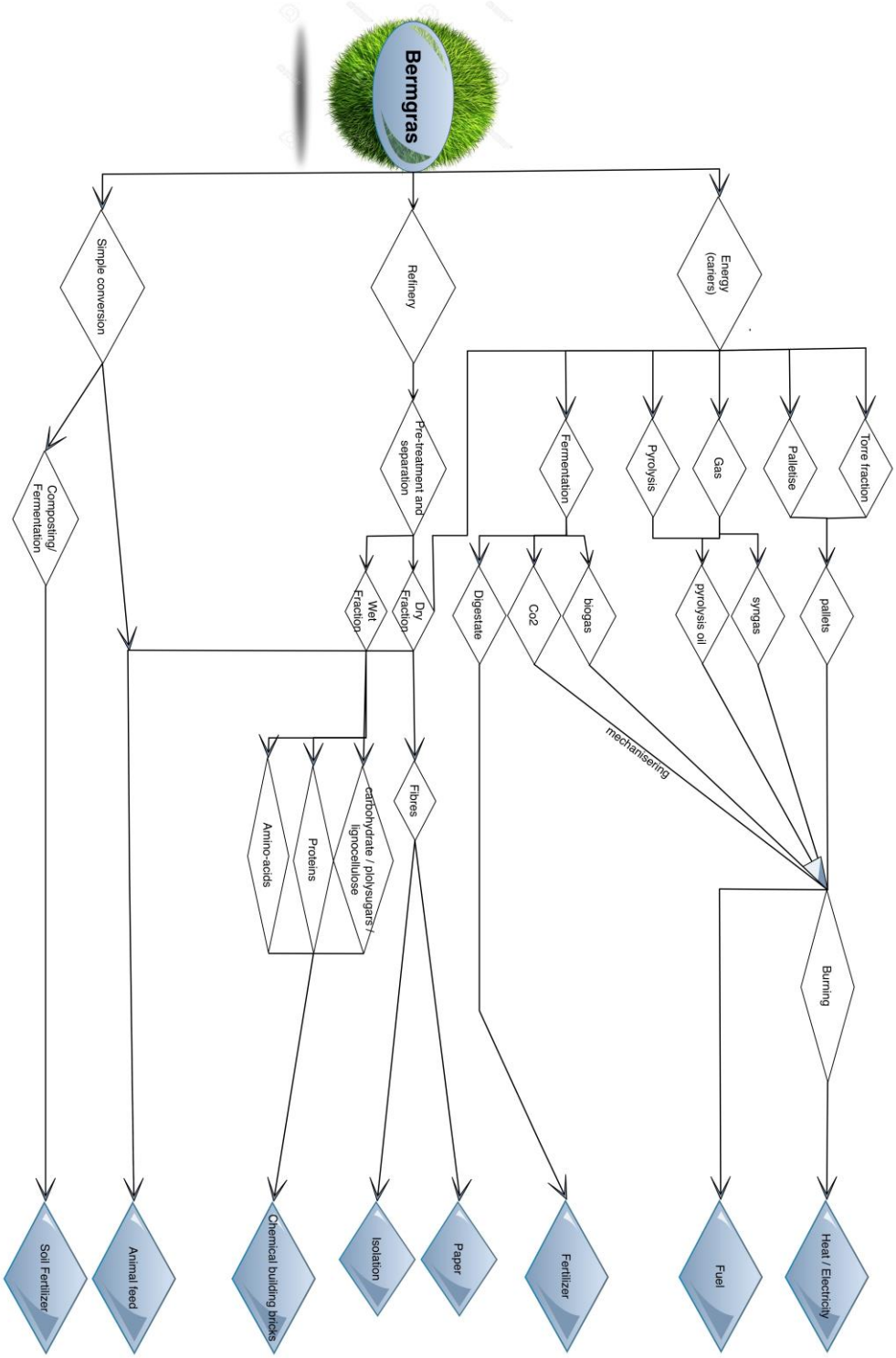
14 Appendix

A. Figures

i. Overall scheme possibilities grass reuse



ii. Table of Seasonal Characteristics of garden waste composted in Aarbus (Boldrin & Christensen, 2010

Seasonal characteristics of garden waste composted in Aarhus (2007).

	Unit	January	March	April	May	June	August	September	November	Std. dev.[a]	CV (%)[b]
TS	% of ww	51.1	61.7	66.5	70.3	68.5	54.1	63.2	46.0	8.8	1.7
VS	% of TS	72.8	50.6	56.3	33.8	33.3	55.5	59.8	66.3	14.1	7.8
Ash	% of TS	27.2	49.3	43.7	66.2	66.7	44.5	40.2	33.7	14.1	7.8
S	% of TS	0.06	0.05	0.05	0.06	0.02	0.08	0.09	0.07	0.02	11
Cl	% of TS	0.08	0.19	0.05	0.05	0.05	0.10	0.11	0.10	0.05	–
F	% of TS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	–
C-total	% of TS	40.1	25.3	32.1	15.8	18.5	26.5	29.9	39.2	8.8	7.8
H	% of TS	4.8	3.3	3.5	1.8	2.4	3.2	4.1	4.7	1.1	–
N	% of TS	0.57	0.37	0.38	0.35	0.59	0.63	0.76	0.69	0.16	9.6
O	% of TS	24.4	22.8	21.4	14.8	17.4	21.4	32.7	23.4	5.3	–
C/N ratio		70	68	84	45	31	42	39	57	18	–
LHV	MJ/kg TS	15.3	9.9	11.4	6.3	6.7	11.2	12.1	14.3	3.2	–
Si	% of TS	8.8	15	15	25	25	11	14	12	6.2	4.9
Al	% of TS	0.7	1.2	1.3	2.3	2.2	1.2	1.4	1.1	0.52	4.4
Ca	% of TS	1.1	1.4	1.1	2.0	1.2	1.3	1.2	1.1	0.30	8.9
Fe	% of TS	0.31	0.60	0.54	0.94	0.97	0.52	0.62	0.57	0.22	6.6
K	% of TS	0.53	0.69	0.86	1.2	1.4	1.0	1.2	0.72	0.30	6.6
Mg	% of TS	0.10	0.15	0.13	0.23	0.22	0.18	0.20	0.13	0.05	6.2
Mn	% of TS	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.01	15
Na	% of TS	0.27	0.45	0.34	0.64	0.55	0.35	0.35	0.36	0.13	6.9
P	% of TS	0.07	0.06	0.08	0.08	0.11	0.12	0.17	0.08	0.04	9.6
Ti	% of TS	0.04	0.08	0.08	0.13	0.16	0.07	0.08	0.05	0.04	7.6
As	mg/kg TS	1.3	2.0	2.6	2.2	2.7	2.2	3.6	2.9	0.68	9.0
Ba	mg/kg TS	104	140	189	282	283	170	199	135	66	7.2
Be	mg/kg TS	0.25	0.43	0.45	0.52	0.63	0.36	0.43	0.37	0.11	12
Cd	mg/kg TS	0.22	0.19	0.26	0.15	0.32	0.21	0.20	0.18	0.05	9.8
Co	mg/kg TS	1.0	2.2	1.5	2.6	3.2	2.7	1.8	1.7	0.72	9.9
Cr	mg/kg TS	8.6	17	16	31	23	16	20	13	6.7	14
Cu	mg/kg TS	7.4	10	9.3	11	17	14	13	11	3.2	14
Hg	mg/kg TS	<0.02	<0.03	<0.04	<0.02	<0.05	<0.03	<0.04	<0.04	0.01	18
Mo	mg/kg TS	<1.7	<3.1	<2.7	<4.2	<3.6	<2.6	<1.9	<1.6	0.92	–
Nb	mg/kg TS	<1.8	<15	<2.6	<4.1	<4.2	<2.6	<1.9	<1.6	4.6	–
Ni	mg/kg TS	2.0	4.6	3.5	4.9	5.1	4.7	3.5	3.7	1.0	8.1
Pb	mg/kg TS	5.2	7.3	6.1	7.4	12	11	8.7	8.0	2.3	12
Sb	mg/kg TS	0.00	0.07	0.03	0.06	0.00	0.20	0.00	0.00	0.64	17
Sc	mg/kg TS	0.87	1.4	1.2	3.0	1.9	1.5	1.3	1.4	4.3	5.4
Sn	mg/kg TS	<6.2	<15	<13	<17	<18	<8.7	<9.4	<8.0	18	–
Sr	mg/kg TS	58	57	65	110	90	68	75	67	5.7	4.5
V	mg/kg TS	6.8	13	12	21	24	13	15	9.2	9.2	5.3
W	mg/kg TS	<17	<31	<27	<42	<36	<26	<19	<16	2.8	–
Y	mg/kg TS	2.5	4.7	4.7	10	9.0	4.6	4.8	3.2	13	14
Zn	mg/kg TS	58	51	40	54	63	84	66	69	67	15
Zr	mg/kg TS	35	48	89	172	219	66	113	39	8.8	13

[a] Absolute value – calculated based on the mean value of the eight samples. It describes the (seasonal) variability of the samples.
[b] Relative uncertainty – associated to the result of each single analysis. It describes the uncertainty due to analytical and sampling errors (from Boldrin (2009)).

B. MCA filled in questionnaires during the stakeholders meeting on 06-09-15

WAGENINGEN UR
For quality of life

Enquête Stakeholderworkshop

Bedrijf: Gemeente Westerveld Naam: Sieb Klinstra

		1					6	
A.	Een eindproduct	X						Meerdere eindproducten
B.	Enkele stappen	X						Veel stappen
C.	Weinig voorkennis			X				Veel voorkennis
D.	Weinig onderzoek		X					Veel onderzoek
E.	Geen maatregelen		X	X				Veel maatregelen
F.	Enkele regels		X					Veel regels
G.	Individueel		X					Samenwerking meerdere partners
H.	Direct			X				Lange termijn
I.	Minder duurzaam						X	Meer duurzaam
J.	Onderaan piramide				X			Bovenaan piramide
K.	Zeker	X						Onzeker, maar met potentie
L.	Kleine investering	X						Grote investering
M.	Vervangt enkel product						X	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 6
B. 6
C. 2
D. 1
E. 4
F. 1
G. 2
H. 5
I 1
J. 6
K. 2
L. 1
M. 5

WAGENINGEN UR
For quality of life

Enquête Stakeholderworkshop

Bedrijf: Van Kooten Frans bv Naam: B. L.

		1					6	
A.	Een eindproduct	☐	☐	☐	☐	☐	☒	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☒	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☒	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☐	☐	☒	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☒	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☒	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☒	☐	☐	☐	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☒	☐	☐	☐	Meer duurzaam
J.	Onderaan piramide	☐	☒	☐	☐	☐	☐	Bovenaan piramide
K.	Zeker	☒	☐	☐	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☒	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☐	☒	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 1
B. 6
C. 3
D. 3
E. 1
F. 6
G. 1
H. 1
I. 4
J. 3
K. 1
L. 3
M. 2

WAGENINGEN UR
For quality of life

Enquête
Stakeholderworkshop

Bedrijf: Agrarservice ..... Naam: Geert Vandenhole

		1					6	
A.	Een eindproduct	☐	☐	☐	☐	☐	☒	Meerdere eindproducten
B.	Enkele stappen	☐	☒	☐	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☒	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☒	☐	☐	☐	Veel onderzoek
E.	Geen maatregelen	☒	☐	☐	☐	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☒	☐	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☐	☒	☐	☐	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☐	☒	Meer duurzaam
J.	Onderaan piramide	☐	☐	☒	☐	☐	☐	Bovenaan piramide
K.	Zeker	☒	☐	☐	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☒	☐	☐	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☐	☒	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 1
B. 6
C. 3
D. 3
E. 1
F. 2
G. 3
H. 5
I 1
J. 4
K. 6
L. 5
M. 5

Enquête
Stakeholderworkshop

Bedrijf: Van Regteren ..... Naam: Hubert van Regteren

		1					6	
A.	Een eindproduct	☐	☐	☒	☐	☐	☐	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☐	☒	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☒	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☒	☐	☐	Veel onderzoek
E.	Geen maatregelen	☐	☐	☒	☐	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☒	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☐	☐	☒	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☐	☒	Meer duurzaam
J.	Onderaan piramide	☐	☐	☐	☐	☐	☒	Bovenaan piramide
K.	Zeker	☐	☒	☐	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☐	☐	☒	Grote investering
M.	Vervangt enkel product	☐	☐	☒	☐	☐	☐	Vervangt meerdere producten

(Met een overkoepelende organisatie!) Waarbij wij als bedrijf ons kunnen aansluiten.

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 4
B. 4
C. 4
D. 3
E. 5
F. 3
G. 1
H. 6
I 2
J. 1
K. 2
L. 3
M. 6

WAGENINGEN UR
For quality of life

Enquête
Stakeholderworkshop

Bedrijf: Gemeente De Wolden Naam: B. Evertz

		1					6	
A.	Een eindproduct	☐	☐	☐	☐	☐	☒	Meerdere eindproducten
B.	Enkele stappen	☐	☒	☐	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☐	☐	☒	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☒	☐	☐	Veel onderzoek
E.	Geen maatregelen	☐	☒	☐	☐	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☒	☐	☐	☐	Veel regels
G.	Individueel	☐	☒	☐	☐	☐	☐	Samenwerking meerdere partners
H.	Direct	☐	☒	☐	☐	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☐	☒	Meer duurzaam
J.	Onderaan piramide	☐	☒	☐	☐	☒	☐	Bovenaan piramide
K.	Zeker	☒	☐	☐	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☒	☐	☐	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☒	☐	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 6
B. 2
C. 6
D. 4
E. 2
F. 3
G. 2
H. 2
I 6
J. 2
K. 1
L. 2
M. 4

WAGENINGEN UR
For quality of life

Enquête
Stakeholderworkshop

Bedrijf: GCZWD ..... Naam: JAN VAN GOOR

		1					6	
A.	Een eindproduct	☐	☐	☒	☐	☐	☐	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☐	☒	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☒	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☒	☐	☐	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☒	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☒	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☒	☐	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☒	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☒	☐	Meer duurzaam
J.	Onderaan piramide	☐	☐	☒	☐	☐	☐	Bovenaan piramide
K.	Zeker	☐	☐	☐	☐	☒	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☒	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☒	☐	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 4
B. 3
C. ~~2~~ 3
D. 5
E. 3
F. 4
G. 5
H. 5
I 4
J. 4
K. 4
L. 3
M. 5

p2.0 Regent
J2.0 Lelystad

WAGENINGEN UR
For quality of life

Enquête
Stakeholderworkshop

Bedrijf: Waterschap Reest en Wieden Naam: Robert Pansenbroeg / Johan Snippe

		1					6	
A.	Een eindproduct	☐	☐	☐	☒	☐	☐	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☒	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☐	☒	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☐	☐	☒	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☐	☐	☒	Veel maatregelen
F.	Enkele regels	☐	☐	☒	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☒	☐	☐	Samenwerking meerdere partners
H.	Direct	☐	☐	☒	☐	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☐	☒	Meer duurzaam
J.	Onderaan piramide	☐	☐	☐	☒	☐	☐	Bovenaan piramide
K.	Zeker	☐	☐	☒	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☒	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☐	☒	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 5
B. 2
C. 3
D. 2
E. 2
F. 3
G. 1
H. 3
I 1
J. 5
K. 2
L. 3
M. 6

Enquête
Stakeholderworkshop

Bedrijf: VAN REGTEREN Naam: Jacob Heijnens

		1					6	
A.	Een eindproduct	☐	☐	☐	☐	☐	☒	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☐	☒	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☒	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☐	☒	☐	Veel onderzoek
E.	Geen maatregelen	☐	☐	☒	☐	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☐	☐	☐	☒	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☐	☐	☒	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☒	☐	Meer duurzaam
J.	Onderaan piramide	☐	☒	☐	☐	☐	☐	Bovenaan piramide
K.	Zeker	☐	☐	☒	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☒	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☒	☐	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. **1** is uiterst belangrijk, 6 het minst belangrijk.

A. 1
B. 3
C. 3
D. 2
E. 3
F. 6
G. 1
H. 1
I 1
J. 3
K. 3
L. 2
M. 2

Enquête
Stakeholderworkshop

Bedrijf: ..... Naam: .....

Samenwerkingsorganisaties De Wilde Hoogte

		1					6	
A.	Een eindproduct	☐	☐	☐	☐	☐	☒	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☐	☐	☐	☒	Veel stappen
C.	Weinig voorkennis	☒	☐	☐	☐	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☐	☐	☒	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☒	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☐	☒	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☒	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☐	☒	Meer duurzaam
J.	Onderaan piramide	☐	☐	☐	☐	☒	☐	Bovenaan piramide
K.	Zeker	☐	☒	☐	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☒	☐	☐	☐	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☒	☐	☐	Vervangt meerdere producten

werkgelegenheid.
veel verschrade daarmee van maken.

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 1
B. 3
C. 2
D. 3
E. 2
F. 2
G. 1
H. 2
I 1
J. 1
K. 2
L. 1
M. 2

alles is belangrijk.

WAGENINGEN UR
For quality of life

Enquête
Stakeholderworkshop

Bedrijf: ..... Naam: Marjon de Brand

Samenwerkingsorg De Wolden Hoogeveen

		1					6	
A.	Een eindproduct	☐	☐	☐	☐	☐	☒	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☐	☐	☐	☒	Veel stappen
C.	Weinig voorkennis	☒	☐	☐	☐	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☐	☐	☒	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☒	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☐	☒	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☒	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☐	☒	Meer duurzaam
J.	Onderaan piramide	☐	☐	☐	☐	☒	☐	Bovenaan piramide
K.	Zeker	☐	☒	☐	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☒	☐	☐	☐	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☒	☐	☐	Vervangt meerdere producten

Weidegelegenheid
Veel gras opwerken — schrale beem → biodiversiteit

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A.	1	**F.**	2	**K.**	2
B.	3	**G.**	1	**L.**	1
C.	2	**H.**	2	**M.**	2
D.	3	**I**	1		
E.	2	**J.**	1		

Enquête
Stakeholderworkshop

Bedrijf: ...Zuiderma..... Naam:...Michiel.....

		1					6	
A.	Een eindproduct	☐	☐	☐	☒	☐	☐	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☒	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☐	☐	☒	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☐	☐	☒	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☐	☒	☐	Veel maatregelen
F.	Enkele regels	☒	☐	☐	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☐	☐	☒	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☐	☒	Meer duurzaam
J.	Onderaan piramide	☐	☐	☐	☐	☐	☒	Bovenaan piramide
K.	Zeker	☐	☐	☒	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☒	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☒	☐	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 4
B. 3
C. 6
D. 6
E. 5
F. 1
G. 6
H. 6
I 6
J. 6
K. 3
L. 4
M. 4

WAGENINGEN UR
For quality of life

Enquête
Stakeholderworkshop

Bedrijf: Bestuur gebiedscoöperatie ..... Naam: Henk Lammers

		1					6	
A.	Een eindproduct	☐	☐	☒	☐	☐	☐	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☒	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☐	☒	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☒	☐	☐	☐	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☒	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☒	☐	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☒	☐	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☐	☒	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☒	☐	☐	Meer duurzaam
J.	Onderaan piramide	☐	☐	☒	☐	☐	☐	Bovenaan piramide
K.	Zeker	☐	☐	☒	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☒	☐	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☒	☐	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 6
B. 1
C. ~~2~~
D. 4
E. 1
F. 3
G. 2
H. 3
I 3
J. 2
K. 1
L. 3
M. 6

WAGENINGEN UR
For quality of life

Enquête Stakeholderworkshop

Bedrijf: ..... Naam: Rosalie Rooze

		1					6	
A.	Een eindproduct	☐	☐	☐	☒	☐	☐	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☒	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☒	☐	☐	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☐	☒	☐	☐	Veel onderzoek
E.	Geen maatregelen	☐	☐	☐	☒	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☒	☐	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☐	☐	☒	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☒	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☒	☐	☐	Meer duurzaam
J.	Onderaan piramide	☐	☐	☐	☐	☒	☐	Bovenaan piramide
K.	Zeker	☐	☐	☐	☒	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☒	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☐	☒	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 4
B. 3
C. 4
D. 4
E. 3
F. 2
G. 1
H. 1
I 2
J. 3
K. 3
L. 2
M. 3

2.0 logistiek
10.0 Publiciteit

WAGENINGEN UR
For quality of life

Enquête Stakeholderworkshop

Bedrijf: L16 Naam: D.R. Meerkerk

Simpel Middel

		1					6	
A.	Een eindproduct	☐	☐	☐	☒	☐	☐	Meerdere eindproducten
B.	Enkele stappen	☐	☐	☒	☐	☐	☐	Veel stappen
C.	Weinig voorkennis	☐	☐	☒	☐	☐	☐	Veel voorkennis
D.	Weinig onderzoek	☐	☐	☒	☐	☐	☐	Veel onderzoek
E.	Geen maatregelen	☐	☐	☒	☐	☐	☐	Veel maatregelen
F.	Enkele regels	☐	☐	☐	☒	☐	☐	Veel regels
G.	Individueel	☐	☐	☐	☒	☐	☐	Samenwerking meerdere partners
H.	Direct	☐	☐	☐	☒	☐	☐	Lange termijn
I.	Minder duurzaam	☐	☐	☐	☐	☒	☐	Meer duurzaam
J.	Onderaan piramide	☐	☐	☐	☒	☐	☐	Bovenaan piramide
K.	Zeker	☐	☐	☒	☐	☐	☐	Onzeker, maar met potentie
L.	Kleine investering	☐	☐	☐	☒	☐	☐	Grote investering
M.	Vervangt enkel product	☐	☐	☐	☐	☒	☐	Vervangt meerdere producten

Geef de criteria een cijfer qua belangrijkheid voor u. 1 is uiterst belangrijk, 6 het minst belangrijk.

A. 1
B. 2
C. 3
D. 4
E. 5
F. 5
G. 1
H. 4
I 3
J. 5
K. 2
L. 3
M. 1

C. Minutes

i. First meeting client (04-13-2015) made by Vera de Boer

Project in nog in de begin fase (begin december begonnen).

Definitie biomassa: Gebruiken de soorten biomassa die gegeven staan in het overzicht van hoeveelheden biomassa. Het GFT- afval valt niet onder biomassa in dit geval, want valt onder een andere regeling. De vraag is of we een of meerdere biomassa gaan gebruiken. Waarschijnlijk zijn gras en hout snippers het meest bruikbaar om te gaan hergebruiken. Welke biomassa we kiezen hangt af van de interessante ondernemers (zie stuk over presentatie 23 april)

Belangrijke punten voor project:

- Kwaliteit van de rest stromen om er iets mee te doen.
- Wat is er nodig? (qua materialen/ technieken)
- Toepasbaarheid in de omgeving vs. Literatuur/achtergrond informatie

Toepasbaarheid is erg belangrijk. Dus eerst globaal een aantal mogelijkheden opzoeken, die presenteren in the meeting van 23 april. Hiervan uit 3 scenario's kiezen en verder onderzoeken en uitwerken. Voor mogelijkheden; hoe hoger in de piramide hoe beter.

Deel van de ondernemers zijn al bezig met groen:

- Verwerker biomassa (meer financieel gericht)
- Grasdrogerij
- Firma Zuiderma
- Geert Lindenhols (een van de presentatoren 23 april)

Burgers hebben (nog) geen invloed op dit project. Er zijn wel burger innovatieve die iets met biomassa doen, zoals wat gebeurt er met biomassa en hoe kan je het hergebruiken. De gemeente zelf gaat er niets mee doen, maar ondernemers wel. Het is handig als onze ondervinden die we gaan doen aansluiten op huidige praktijken, zodat de innovatie laagdrempeliger wordt. De veranderingen moeten het wel waard zijn (hoog rendement).

Regels voor gras: maaisel van gras valt onder de compost regeling en is schoon genoeg om hergebruikt te worden. Het wordt nu als compost materiaal gebruikt

23 april:
Organisator van avond: Jan Goor – nummer: 0627745955
Introductie avond met verschillende partijen/ondernemers die al iets met biomassa stromen doen of willen gaan doen.
Gaan presentatie houden over toepassingen voor biomassa. Aantal voorbeelden noemen en vragen welke toepassingen zijn interessant vinden. Belangrijke punten voor de presentatie:

- Definitie biomassa + hoeveelheden
- Welke rest stromen zijn er bij de ondernemers (ondernemers met vergelijkbare rest stromen)
- Vragen: 1 of meerdere soorten, globaal of specifiek
- Vragen baseren op de aanwezige stakeholders
- Welke stromen zijn interessant voor de ondernemers
- Wat willen ze weten
- Welke biomassa's vinden de ondernemers interessant

24 april
Blijven slapen na de presentatie avond (mogelijkheden in het gemeente huis of bij Sander)

Vrijdag ochtend langs bij verschillende ondernemers die al iets met groen doen en kijken wat er al wordt gedaan met biomassa. (begeleider: Herman Bakker en misschien nog een andere persoon)

Deadline's:

- Opzet presentatie van donderdag 23 april: dinsdag 21 april opsturen naar Herman Bakker en Rosalie Rooze

Te doen:

- Momo vragen contacten Drenthe. Misschien zijn er leuke dingen te zien voor 24 april.

Summary:
We are going to do a presentation on the 23th of April. In this presentation we give the present stakeholders, next to the already given applications, a view applications options of the reuse of biomass. We also going to ask certain question, such as in which biomass they are interested in and which biomass waste they have. With this we can define our scope.
After the presentation, we will sleep over there, so the next morning (24th of April) we can visit a few stakeholders that already do something with biomass. This will give us a good idea what is already done with the biomass.
From this meeting we learned that is was very important that our reuse options of biomass has to be useable in practice in Drenthe.

ii. First presentation Drenthe(04-23-15), made by Jelte Vredenbregt)

After a prosperous voyage from Wageningen to the snack bar in Ruinerwold we arrived just in time at the former municipal hall of Ruinerwold. After a nice cup of tea the meeting started: the chairman of the meeting explained the planning of the evening: during the first hour all presentations should take place, after that there was the opportunity to discuss potential projects with the presenters and finally the Gebiedscoöperatie would choose 2 projects to subsidise.

5 entrepreneurs had a presentation about their plans or experiences with innovative biomass use:

- Bioforte about sustainably heating buildings using woodchips.
- A guy who used all kinds of biomass (but not specifically biomass waste) in sustainable buildings.
- -Agra Service about using rapeseed to produce oil and about producing pellets from leaves and roadside grass to heat buildings.
- Water board Reest & Wieden about a wood-like material made from grass clippings and about using bokashi (fermented biomass) instead of compost as soil conditioner.
- Partners for Innovation about general processes regarding biomass waste use.

After the entrepreneurs Rianne & Jelte presented our group and our findings.

Then there were 3 rounds during which all presenters were standing at a table. Persons interested in our presentation dropped by to discuss possible collaboration. Although some projects sounded interesting and promising, they did not fit with our objective to use biomass waste. However ideas for projects were made at the other tables. The board of the Gebiedscoöperatie chose 2 projects that will receive a subsidy. Those are the sustainable heating project of Bioforte and a project about using grass waste. The grass waste project is not so well defined yet, but we will receive information about it later on as well as information about the other project. Then we will explore what our contribution will be to one of the projects.

After the meeting we drank a beer with Rosalie, Jan, Herman and several other nice 'Drentenaren'. We had a very nice night and after a few hours' sleep we drove to some place to be guided through

Zuidwest-Drenthe by Jan and Herman. First we spoke with the owner of a major biomass waste processing company in Zuidwest-Drenthe. He explained lots of things about biomass waste processing, which was a real clarification to us. Afterwards he showed some huge piles of all kinds of biomass waste that could be used in an innovative way but weren't at the moment.

After the first meeting we went to Agra Service, where a nice chap told us about all things that can be done with rapeseed. This was really inspiring, but not particularly useful for our project. However he also made pellets out of dead leaves and roadside grass which he used to heat his house and the hair studio of his wife. This saved him a lot of money and it showed an approachable way to apply biomass waste.

Then we went to a swimming pool that was heated by burning woodchips. That was awe-inspiring.We had a short conversation with Herman about the continuation of the project and then drove away.

iii. PechaKuchaCafé Drenthe (04-23-15), made by Gebied coöperatie De Wolden Hoogeveen

'Wat kunnen lokale ondernemers met groene reststromen of hergebruik?"

We kijken terug op een leerzame avond waarin 6 sprekers, in kort en bondige presentaties, ons uitleg hebben gegeven over diverse Biobased onderwerpen;
De doelstelling van de avond is naast interessante presentaties te komen tot kansen om met lokale ondernemers samen te werken en zodoende de mogelijkheden van de biobased economy om te zetten in concrete project ideeën.

Han Langevoort – Houtsnippers voor verwarming
Een biomassainstallatie geeft precies dezelfde warmte als een "gewone" gasgestookte installatie. Hij doet het alleen nagenoeg CO2 neutraal en vaak voordeliger. En dat zie je terug. Niet alleen in uw energierekening en in de waarde van het vastgoed, maar ook in de waardering van een groeiende groep "bewuste" klanten, wat een positief effect heeft op de aantrekkelijkheid en MVO prestatie van uw organisatie.
Bio Forte is dé nieuwe aanbieder van warmte met biomassa op lokaal niveau in Nederland. Ze leveren groene warmte en mogelijk ook stroom met snoeihout uit uw eigen omgeving!
Energiebedrijf Bio Forte BV ontwerpt, realiseert en exploiteert biomassagestookte installaties voor duurzame warmtelevering.

Voor meer informatie: www.bioforte.nl

Jan Vloo – Bouwmateriaal uit hergebruikt materiaal
De Biobased Economy is een duurzame economie gebaseerd op materialen uit de levende natuur waarbij groene grondstoffen in eerste instantie worden ingezet voor de productie van chemicaliën en materialen en daarnaast voor energie.
Deze cascadering, waarbij je kort gezegd de waardevolle onderdelen van de groene grondstoffen betrekt voor verwerking in de farmacie en chemie, vervolgens voor voedsel en diervoeding, daarna de transport brandstoffen en wat er overblijft voor energie, is een voorwaarde om de transitie te doen slagen. Uitgangspunt is dat er geen conflict bestaat met de voedselketen wat je kunt bereiken door hernieuwbare grondstoffen te gebruiken.
De BBE kenmerkt zich door samenwerking. Niet alleen binnen de bedrijfstak maar door de hele bedrijfskolom waarbij er hele nieuwe ketens ontstaan. De uitdaging is om deze nieuwe ketens aan elkaar te knopen, belemmeringen weg te nemen en Business Cases op te stellen.

Voor meer informatie: www.biobasedeconomy.nl

Geert Lindenhols – Mogelijkheden van koolzaad
Geert Lindenhols is een agrariër uit Zuidwolde met een veelzijdig landbouwbedrijf. Op het bedrijf worden diverse gewassen geteeld zoals fabrieksaardappelen, suikerbieten, tarwe, maïs en koolzaad. Geert is al enige jaren bezig met de teelt en verwerking van koolzaad tot diverse eindproducten. Hij heeft zich gespecialiseerd in nieuwe toepassingen voor koolzaadolie. Koolzaadolie heeft diverse toepassingsmogelijkheden, te weten: als brandstof voor motoren, smeermiddel voor bijv. kettingzaag, en als basis van Bio Controle Bloedluis. (Dit is de puur natuurlijke bestrijding van bloedluis.)
Koolzaadstro kan gebruikt worden als strooisel, eventueel gehakseld op 4 cm (als pensprik rundvee), gemalen als (box)strooisel voor rundvee, paarden, varkens en kippen. Koolzaadkoek is een restproduct wat overblijft na het persen, het bevat veel eiwit en diverse gezonde vitamines en is zeer gezond voor rundvee en varkens.

Voor meer informatie: www.agraservicelindenhols.nl

Robert Pannenborg – Fermenteren van organisch materiaal: Bokashi
Het Waterschap Reest en Wieden heeft samen met ondernemers een idee uitgewerkt om van berm maaisel (groen afval) bokashi te maken. Bokashi is een natuurlijke grondverbeteraar vergelijkbaar met compost maar in plaats van het te composteren wordt het groenafval gefermenteerd. Fermenteren gebeurt met een zgn. biocultuur die toegevoegd wordt aan het groenafval. Dit leidt tot een natuurlijke grondverbeteraar. Deze grondverbeteraar is goed voor de landbouwgrond, want die wordt steeds armer aan organische stoffen. Daardoor houdt de grond steeds minder mineralen vast, spoelt de grond sneller uit en is deze veel droogtegevoeliger."
Zowel waterschappen als ook gemeenten hebben vele duizenden kilotonnen aan groen afval wat of gestort wordt (en waarvoor betaald moet worden) of blijft liggen langs de watergangen. Om nu samen met lokale ondernemers te zoeken naar nieuwe toepassingen kan het groen afval op een goede maner hergebruikt

Voor meer informatie: www.reestenwieden.nl

Definitie Bokashi: (Bokashi is het Japanse woord voor "goed gefermenteerd organisch materiaal", het is een manier om je organische resten om te zetten tot een zeer rijke bodemverbeteraar. Bokashi is het resultaat van een eeuwenoude techniek: fermentatie. Door toevoeging van effectieve micro-organismen (microferm) en het anaeroob (zonder zuurstof) verwerken van je resten, maak je van je eigen organische resten een waardevolle bodemverbeteraar. Om een optimaal resultaat te behalen worden meestal zeeschelpenkalk en kleimineralen toegevoegd, maar dit hangt af van de toepassing)

Kristiaan Tetteroo – Chemische toepassingen
De biobased economy betrekt haar grondstoffen uit de levende natuur – biomassa. Gewassen en reststromen uit de agrarische sector en de voedingsmiddelenindustrie worden als 'groene grondstof' gebruikt voor de productie van materialen, chemicaliën, energie en brandstof. De biobased economy biedt economische kansen, draagt bij aan energieonafhankelijkheid en reductie van broeikasgassen. De circular economy zet in op het grootschalig terugwinnen en hergebruiken van grondstoffen. Door producten aan het einde van de levenscyclus in te zamelen en de materialen te scheiden kunnen deze weer voor nieuwe producten worden ingezet. De circulaire economie vraagt om innovatieve ontwerpen en productiesystemen, andere organisatievormen, zoals retourlogistiek en nieuwe verdienmodellen. Samenwerking in de keten is van strategisch belang. Behoeftevervulling en diensten worden belangrijker dan eigendom van producten.

Voor meer informatie: www.partnersforinnovation.com

Rianne van der Meiracker en Jelte Vredenbegt, Wageningen Universiteit – Regioleren
Een vijftal studenten zijn gestart met een onderzoek naar de verwerking van groene reststromen in de regio Zuidwest Drenthe. De studenten hebben tijdens de avond de behoefte van lokale ondernemers geïnventariseerd en gaan in de komende 2 maanden onderzoeken welke verwerkingsmogelijkheden van reststromen bermmaaisel en houtsnippers voor de regio.

Tijdens een verdiepend worldcafé, waarin in drie ronden kennis bij elkaar werd gebracht, is de slag gemaakt om proefprojecten te initiëren. De twee projecten die zijn uitgekozen zijn het project van Han Langevoort (houtsnippers voor verwarming) en Robert Pannenborg (Fermenteren van organisch materiaal, Bokashi). De laatste zal nog een verdiepingsslag moeten maken.
In twee projectgroepen zullen, in samenwerking met studenten van Wageningen Universiteit, projectideeën, projectvoorstellen en kennisvragen worden geformuleerd. Hiervoor hebben wij uw input nodig! Heeft u ideeën en/of wilt u graag meedenken over de onderzoeksvragen en de kansen voor projecten hier in de regio dan vernemen wij dit graag.

Wij nodigen u van harte uit plaats te nemen in één van de projectgroepen. Stuur een e-mail naar Berber Jansen, E: berberjansen@gczwdrenthe.nl

iv. Stakeholder workshop (06-09-15), made by Vera de Boer and Rosalie Rooze

Gebied coöperatie wil meer halen uit reststromen. Studenten hebben vijf scenarios geschreven over wat kun je doen met gras?
De studenten hebben een vragenlijst gemaakt om hier voor in de regio een scenario te kiezen.

Verschillende scenarios zijn:

- Composteren als bodemverbeteraar
- Gras direct omzetten naar pellets of fermenteren naar biogas/bodemverbeteraar
- Gras scheiden in droge en natte. De natte fractie gebruiken om eiwitten te maken(veevoer), droge fractie composteren (simpele raffinage)
- Gras scheiden in droge en natte. De natte fractie gebruiken om eiwitten te maken (veevoer), droge fractie gebruiken om pellets te maken voor in de kachel, warmte en energie (middel complexe raffinage)
- Gras scheiden in droge en natte. De natte fractie gebruiken om eiwitten te maken(veevoer/omzetten naar eiwitten voor gebruik voedsel). Daarna verder gaan met de natte fractie om er melkzuur uit te halen. Droge fractie gebruiken om pellets of papier te maken (complexe raffinage)

Uit alle mogelijkheden de meest kansrijke toepassingen voor Drenthe uitgezocht.

Bij gras raffinage wordt het gras gescheiden in een natte en droge fractie. Dit gebeurt met een pers. Hierdoor wordt de celwand opengebroken en wordt het makkelijker om de voedingsstoffen en energie uit het gras te halen.

Multicriteria analyse, per criteria de vraag vooral de bereidheid tot. Uitkomst op eerste ruwe telling: Scenarios drie en vier, simpele bio raffinage en minder complexe bio raffinage. De verschillende criteria zijn gescoord. De antwoorden in een tabel verwerkt die de studenten gemaakt hebben.
Verschillende discussie punten waren:

- Economie, hoe zit het met afzet markt? Wat is de mogelijke opbrengst
- Hoeveel maaisel is er beschikbaar in de regio? Waar kan het naartoe wie kan het verwerken?
- Hoeveelheid gras die gebruikt wordt in het proces.

De blik op samenwerking buiten Drenthe: eerst binnen de gemeente samenwerken. De samenwerking bestaat tussen de gemeente Hoogeveen en de Wolden samenwerking. Ook de gemeente Westerveld is betrokken. Samenwerken en kennisdelen staat voorop. Een mobiele raffinage niet handig, want iedere gemeente krijgt het gras te gelijk. Gras is een seizoen product, kort maar heftig. Het is belangrijk om het gras te drogen, bewaren en opslaan. Het gras seizoen is kort maar krachtig, de dure installatie moet voldoende draaien.

Voor raffinage kan de maaifrequentie kan anders worden geregeld. Voor het raffineren is er opslag ruimte nodig voor gras. Een optie voor het opslaan van gras is inkuilen. Er is genoeg ruimte in de gemeente. De bewaartijd van het gras heeft geen effect op het eindproduct, wel hoe schoon het gras is. Het gras moet schoon zijn van straatafval en zand voordat het gebruikt kan worden. De vraag is hoe krijg je het gemaaid, schoon zonder verontreiniging en hoe krijg je het in de kuil om er iets mee te doen. De verontreiniging is moeilijk. Het blik en plastic in het gras is een probleem. Het afval kan er handmatig uit gehaald worden. Dit levert werkgelegenheid op.

Doel gebiedscoöperatie werkt volgens de 3 O's : onderwijs, ondernemers en overheid. Er is behoefte aan samenwerking. Door de gebiedscoöperatie is het mogelijk om
samen te investeren in een groter belang. Ideeën komen er wel, maar hoe breng je het project verder. De gemeente kan investeren in gras. Meerdere jaren investeren geeft te groot risico, daardoor kunnen ondernemers niet investeren.

De gemeente kan niet zomaar geld uitgeven, want het is het geld van de burgers. Als gemeente veel bermgras heeft kan er gekeken worden naar meerjarige afspraken. De gemeente moet de aanvoer bermgras garanderen en een prijs afspreken voor vijf jaar. Volumes vastleggen, wil je inzetten op dikke of dunne fracties. Wat heb je nodig om een project te draaien? Waar gaan we voor? Voor de scheiding van de dunne of dikke fractie, welk gewas hebben we daarvoor nodig? Samen gaan we ervoor zorgen dat het gras in balen komt. Dit project samen met ondernemers en de gebiedscoöperatie gaan uitvoeren. Belangrijk is om een transport model op te zetten.

Het laten liggen van het gras heeft een aantal regels in verband met de biodiversiteit. De zaden uitlaten vallen en het schralen van het gras heeft een positief effect op de biodiversiteit. Het gras moet minimaal 4 en maximaal 10 dagen laten liggen voor de zaden uitval, dit zorgt voor ecologische bermbommen. Dit is in conflict met het gras als het gras geschikt moet zijn voor inkuilen. Dan moet het gras niet langer liggen dan 48 uur. Het maaisel minimaal 4 dagen blijven liggen langs de rijkswegen. Zo vers mogelijk gras verwerken is belangrijk voor hergebruik. Dit kan bij het waterschap. Een andere maai manier is om de maai periode aanpassen naar begin september, met de gedachte dat de zaadval van de planten al geweest is voordat je gaat maaien. Dit beleid geldt in buitengebied Westerveld. Met deze manier kan je het gras direct afvoeren. Alleen belangrijke punten al een keer eerder maaien, zoals in bochten en tussen bermen. Er zijn verschillende manieren en momenten van maaien. Er kunnen verschillende opties bekijken worden waarbij het gras zo snel mogelijk na maaien verwerkt kan worden of kan worden ingekuild. Het is belangrijk om langdurige afspraken te gaan en dat beide partijen, zowel ondernemer als overheid, zich aan gaan houden.

Het scenario om eiwitten te gaan halen spreekt veel mensen. Deze eiwitten kan je dan gebruiken als veevoer voor koeien, kippen of varkens. Varkens kunnen niets met gras, maar wel met eiwit geraffineerd uit gras. Hierdoor heb je minder import van soja, dus is duurzame optie. Een probleem kan zijn dat in schrale grassen minder voedingswaarden zitten. Een optie is dan om de berm te gaan te bemesten. Misschien helpt dit ook met het mest overschot. Een andere optie om speciaal gras zaaien in berm om hoge eiwit gehaltes te creëren.

Regels geven problemen in de ogen van ondernemers. Het komt over dat de regels te veel restricties geven. Misschien moet de regelgeving aangepast worden. De regels worden beschreven door provincie Drenthe en de waterstaat.

Wat is het effect van het maaisel sneller van berm af te halen voor de verwerking? Onderzoek in gekweekt gras om eiwit uit te houden in vergelijking tot bermgras? De vocht die uit gras komt kan eiwitrijk zijn of niet. Er kan ook kali vrij komen en er komen producten vrij voor gebruik in de landbouw. Droge stof van het gras kan gebruik worden voor de productie van papier.

Er zijn niet alleen arme bermen. Raffineren is een complex proces, met biologische en chemisch processen. Een vijzelpers kan het gras in een dunne (natte) en dikke (droge) fractie scheiden. De eiwit moet je kunnen afzetten en komt uit de natte fractie. Het eiwit kan uit het grassap gehaald worden door er melkzuur bij te voegen en het mengsel te verwarmen. Hierdoor gaan de eiwitten samen klonteren. Dit laat je drogen en zo heb je een blok groene eiwitten. De droge fractie kan gebruikt worden voor de productie van pellets of papier. Het bermgras is het meest geschikt voor het gebruikt in de droge fractie.

De vraag is of er schadelijke stoffen zitten in bermgras door de uitlaatgassen van auto's. Onder schadelijke stoffen verstaan we zware metalen zoals lood en fijnstof. Een andere vragen zijn: wat is de markt is van eiwitten? En wat het verschil tussen gras van de waterstaat in de sloten en bermgras? Het is handig om een excursie naar een raffinage te organiseren om te kijken hoe het er aan toe gaat. Een optie is de Grasraffinage harvesr veenkoloniën.

Welke kansen zien we met het bermmaaisels. Er is bermmaaisel en slootmaaisel beschikbaar, maar nu wordt er eerst gefocust op het maaisel van bermgras.

- Eiwitten: het gras kan geraffineerd worden en er kunnen eiwitten geproduceerd worden. Het eiwit kan worden gebruikt worden als veevoer, maar het kan ook worden omgezet worden in eiwitten die kunnen gebruikt worden in voedsel. Misschien kunnen de eiwitten gebruikt worden als superfoods. Dus welke mogelijkheden zijn er in eiwitten uit gras? (Agrifirm laten aanschuiven.) Het is belangrijk dat er gekeken naar de kwaliteit van de eiwitten die uit gras gehaald worden. Ook moet er gekeken naar de afzetmarkt, wat kan je met eiwitten en waar kunnen we met het eiwit naar toe? Misschien moeten Agrifirm en avebe in beeld worden gebracht? Als de eiwitten gebruikt worden als veevoer, dan kunnen de eiwitten soja vervangen. Als je het afzet tegen soja markt, dan is de impact laag op de markt. De kosten en opbrengsten moeten in beeld worden gebracht. Per verschillende soorten eiwitten zijn er verschillend afzetmarkten, dit moet uitgezocht worden. Er kan ook nog onderzoek gedaan/gegevens verzameld worden naar de eiwitgehaltes in verschillende soorten bermgras..
- Fermentatie
- Raffinage: het gras opdelen in een droge en natte fractie. Dit is een interessante optie, omdat het onbekend is in Drenthe maar is wel genoeg informatie beschikbaar. Er zijn voorbeelden van projecten en daar kan naar gekeken worden. De droge fractie kan composteren en daarna gebruikt worden als bodemverbeteraar. Dit restproduct kan de organische stof gehalte omhoog te brengen in de bodem en kan gebruikt worden in de landbouw. Er zijn ook andere mogelijke met de droge fractie naast composteren, zoals graspalen maken, pellets produceren en papier maken. De afzetmarkt moet nog wel in kaart worden gebracht.
- Duurzaamheidsdag: Bijeenkomst organiseren om een duurzaamheidspers te bekijken. Een optie is naar Jansen in Wijhe loonbedrijf, deze heeft een pers staan. Hier kan dan getest

worden hoe het werkt om gras te scheiden in een natte en een droge fractie. 18 oktober is bijeenkomst raffineren.

- Verdien model maken met de kosten en de opbrengst. Er moet ook onderzoek gedaan worden naar de afzetmarkt. Hierbij kan er gekeken worden naar het verschil tussen agricultuur gras en bermgras. Er kan een demonstratie gedaan worden om te laten zien wat het verschil is tussen agrariër van het land en het bermgras van de gemeente of de reststroom van het waterschap.
- Maaisel leveren zonder dat het ten kosten van gaat flora en fauna.
- Hoeveelheden/ volumes product en grondstof in beeld brengen.

Eventueel met boeren aan de slag gaan om reststroom bermmaaisel te gebruiken als compost (bermgras en boerengras). Er bestaat de mogelijk om koolzaad in de overhoeken van de weg te inzaaien, om deze later te gebruiken in de oogsten en te gebruiken.
Hoe zit het proces van bermgras in elkaar om een dunne en dikke fractie te vormgeven.
Rijkswaterstaat bij het project betrekken. Er zijn meer kansen. Ook Agrifirm betrekken bij vervolg.

Er moet nog veel worden onderzocht. Nu eerst een pers bezoeken en projectvragen formuleren.
Er moet een gesprek aangegaan worden met elkaar om projecten te definiëren. Er moet gekeken worden naar de kwaliteit en prijs fluctuaties. Dit is niet voorspelbaar en nog niet bekend. Het maaisel is heel verschillend per gebied. Hoe ga je het gras oogsten en het project toepassen. Vragen over de kwaliteit van het gras zijn: Hoe haal je het gras binnen? Is het vers? En over welk type gras gaat het?

Wouter Verbeek, onderzoeker, kunnen we bijvragen en vervolgstappen benoemen.
Waterleidingmaatschappij Drenthe missen we aan tafel. Belw advies 0610654580
Elma schoenmaker, bio raffinage, is interessant contact en kunnen we misschien ooit een keer uitnodigen.

Voor vakantie met voorbereidingsgroep aan de slag.