BIO BLUE SOLUTIONS

BLAUWZAAM

avans hogeschool

Biomass for energy neutralization
- Alblasserwaard-Vijfheerenlanden -

Stijn van Hout Celine Marcel Thijs van de Wiel Ozan Solmaz

Group: 32MBTDh

Management summary

According to Rolia Wiggelinkhuijsen (Secretary of NGO Blauwzaam), the NGO has as the goal to become energy neutral in 2030. To accomplish this goal, Blauwzaam wants to know if and how they can use bio-based technologies.

According to Rolia Wiggelinkhuijsen there are five different waste streams in the region Alblasserwaard-Vijfheerenlanden, which need further research to get the region more energy neutral. These five different waste streams are: Grass, Wastewater, manure, dairy factory and willow wood.

For this project, there is been chosen to deal with the wastewater treatment, because the first idea, generating biogas from manure, was no success. The farmers in the region needed and used the manure for themselves and would not give it away or use it for other reasons then using it as compost or to produce energy for their own use.
The research continues and now is looked at the possibility to get PHA out of wastewater and to extrude this PHA into biodegradable plastic foil for the agricultural sector in the region Alblasserwaard-Vijfheerenlanden.

Research is done how to provide PHA out of wastewater. According to the research, this process contains four main steps:

1. Fermentation, 2. Enrichment, 3.Accumulation, 4.Recovery.

Each of these steps has its own machinery to get the PHA out of the sewage sludge. According to the research the storage capacity of the PHA is 40% of the sewage sludge.

To calculate the financial requirements for the installations of PHA production, the population equivalent is needed. The region Alblasserwaard-Vijfheerenlanden has a population equivalent of 344.350,58 p.e. (Population Equivalent)
Based on this research the total investment cost to produce biodegradable plastic foil is €3,730,580
The total annual cost to produce biodegradable plastic foil is €640,391.
The cost-effective selling price for one roll of biodegradable plastic foil is €447.03 exclusive VAT.
Inclusive VAT the cost-effective selling price is €540.90.
To play break-even there should be sold a total amount of 9,006 agricultural bioplastic foil rolls.
Calculated is, that the annual demand is 2,250 rolls per year in the region Alblasserwaard-Vijfheerenlanden. Considering this demand, it should take approximately four years to play break-even. This is the best-case scenario.

There are some discussion points. First off all, it is expected that the development of the technology will allow a reduction of the cost in the future and that the price of the fossil fuel resources will also increase. Second of all the degradability of the plastic foil isn't tested. Based on assumption and some interviews, the plastic will degrade in six months to two years.

Producing PHA out of wastewater is technically possible and feasible. Economically this process is not feasible. The main reason for this is that the costs are too high. The consequence of this is, that the price for one roll of biodegradable plastic is too high. Farmers in this region are not likely to buy the plastic foil, because they do not want to spend €447.03 for one roll of biodegradable plastic.

Preface

In front of you we have the draft report 'Biomass for energy neutralization' -Alblasserwaard-Vijfheerenlanden. The research for making the region Alblasserwaard-Vijfheerenlanden more energy neutral is provided by NGO Blauwzaam. There will be more information about Blauwzaam further in this report. The report is written for NGO Blauwzaam and Avans University of Applied Science.

Four students of the Minor Biobased Technology And Business Development do this research. The names of the students are: Ozan Solmaz, Thijs van der Wiel, Celine Mancel and Stijn van Hout.

Together with Rolia Wiggelinkhuijsen (Secretary of NGO Blauwzaam) the students started this research. When doing research, more people become important for the research. The people who helped with this research are:

- ✓ David Mendez Sevilla , project tutor from Avans University of Applied Science;
- ✓ Rolia Wiggelinkhuijsen, secretary Blauwzaam;
- ✓ Jan Versluis, sustainability at dairy factory de Graafstroom 1908;
- ✓ Jan van Zuijlen, purchasing group at Deltafeed;
- ✓ Peter Willems, contact person of water treatment plant Waterschap Rivierenland;
- ✓ Wobke Gerritsen, technical engineering at Waterschap Rivierenland;
- ✓ Marien Verwolf, Senior specialist green, at department management and maintenance Waterschap Rivierenland;
- ✓ T.W.J. Kobs, graduate student at Avans University of Applied Science.

We aspire to carry a reputation in the bioplastics market for developing usable products for the agricultural sector in the region Alblasserwaard-Vijfheerenlanden. This will be done by treating wastewater and converting PHA out of it. With these bioplastics, that are biodegradable, the plastic waste will be reduced, what will turn out in a more sustainable and energy neutral environment.

We hope you will enjoy reading this report.

Table of content

Definitions

- PE: Polyethylene
- CHP: Combined Heat and Power
- PHA: Polyhydroxyalkanoates
- P.e.: Population equivalent
- VFA: Volatile fatty acids
- Extrusion: The process of converting the plastics beads into an end product or semi-end product.

1. Introduction

1.1 NGO Blauwzaam

Blauwzaam is a non-governmental organisation (NGO) that focuses on initiatives that support and promote reducing energy use and awareness of the region Alblasserwaard-Vijfheerenlanden.
One of the initiatives of the foundation is the realization on an energy neutral region. Part of this initiative is energy agreements (green deals) with municipalities and companies in the region. Green deals are deals between the government and the society. Individuals and companies who want to develop concrete sustainable initiatives have a lot of barriers (such as finance), which could get a deal with the government to take away the barriers. Blauwzaam, as one of the bigger sustainable promoters in the region, has developed two concrete Green Deals. (Both honoured by the government). These two initiatives are unique and applicable on other projects, which underline the efforts of optimum durability. The first one is the construction of a 40km long flowered ribbon and the second one is the energy covenant that gives Blauwzaam member the opportunity to develop initiatives on its own. (Blauwzaam, Blauwzaam gesteund door 2 Green Deals met de overheid, 2012)

Blauwzaam 's mission is to be energy neutral in the region of Alblasserwaard-Vijfheerenlanden by 2030. Blauwzaam wants to work on a sustainable environment by cooperation between business and to create a better world by investing in local business. Furthermore, conservation of nature, a healthy living environment and heritages is what Blauwzaam wants to achieve.

Blauwzaam wants to bring the area higher up by creating improvements in results, process, innovation and awareness by positive communication. (Blauwzaam, Mission, 2016)

1.2 Explanation of the project

Blauwzaam is founded in 2010 and supports and promotes sustainable development on regional scale. The NGO is established in the region Alblasserwaard-Vijfheerenlanden and works on a lot of projects with a network of 150 companies. Blauwzaam has workgroups in construction and housing, communication & PR, energy, knowledge & education, Nature & inspiration, transport & logistics, funding, family companies, water, personal, bio based economy and circular economy. The region Alblasserwaard-Vijfheerenlanden wants to be energy neutral region in 2030. The definition of energy neutral is: Balance between energy demand and renewable energy supply. Renewable energy sources preferably located into the region but can also come from outside the region.
For Blauwzaam, regional energy-neutrality (REN) is based on the concept of Trias Energetica. This concept consists of three basic steps:

1. Reduce the energy demand by energy saving-programs and avoid waste
2. Use renewable sources
3. Make use of the best possibilities of the fossil energy

1.2.1 Sustainable challenges Blauwzaam

The current issue of Blauwzaam is that the progress of making the region Alblasserwaard-Vijfheerenlanden energy neutral in 2030 is going too slow. Blauwzaam already has projects with solar energy, wind energy and water energy. According to Rolia Wiggelinkhuijsen (see preface), energy neutral is the producing of exactly the amount of energy and products we need use to fulfil our needs.

1.2.2 Reason for the project

The reason for the project is, Blauwzaam wants to find out if and how bio based technologies can generate energy from willows or domestic waste or sewage sludge or grass waste or cow farmers waste and if this can contribute energy neutral region A5H.

The goal of Blauwzaam is to make the region Alblasserwaard-Vijfheerenlanden energy neutral in 2030. To become energy neutral the NGO wants/needs to use the bio based economy. This is because only wind, solar and hydro energy the region isn't generating enough energy. According to Blauwzaam there are five different subject to focus on. These five different subjects are: willow wood, sewage sludge, and diary factories waste, grass and cow farmers' waste.

1.3 Project goal

The project goal is to give Blauwzaam advice and a market and technological based paper about if and how they can use bio-based technologies to convert the sewage sludge to plastic film for the farmers in the region to contribute to the energy neutral region A5H in a period of 20 weeks.

1.4 Boundaries

The boundaries are:

- The limited amount of time, which is 20 weeks;
- No research is done on the production of biogas in the production of PHA;
- There is no research done for other products than biodegradable foil for the agricultural market:
- The region is limited (Alblasserwaard-Vijfheerenlanden), so the research is done for a specific area and not the whole Netherlands. This could be expanded though.

1.5 Method of research

In order to get the information for this project different research methods are used. All the methods for the different reports are described.

1.5.1 Plan of Approach

To get all the information for the plan of approach, desk research and field research are done.

Desk research
Desk research has been done for Blauwzaam to understand how the project will be approached, what will be addressed, where also deadlines are set.

Field research
A meeting with Rolia Wiggelinkhuijsen is planned to get more information about the expectation of the project.

The plan got some feedback after the project group visited the organization of Blauwzaam and Avans University.

1.5.2 Intermediate report

Desk research and field research are done to get the information for the intermediate report.

Desk research
Research has been done for five different waste streams. After this research a choice could be made to do further research on one waste stream. The report has been made according to the guidelines of

Avans University.

Field research
To understand which possible implementations would work, farms were visited to look at the techniques being used to create energy or heat, or to reduce energy use, using sustainable techniques and also the difference between theoretical and practical usage. This formed the decision-making.

1.5.3 Stakeholder analyses

Desk research
The stakeholder analysis was presented to the University. Avans did this to determine if the stakeholder analysis is sufficient enough to use the results.

Field research
In order to achieve good insight of the opinion and desires of the farmers concerning price/product and product value adding actions, visitations of farmers has been done.

1.5.4 Final report

The final report will have the standard approach of forming the information and conclusions in one report. Some desk research is required to complete the theoretical background of the project. A total of six farmers and a salesman from the purchases group have been interviewed.

This report is based on the guidelines provided by Avans University

1.6 Reading Guide

In **chapter 2** the choice of the focus of the project is explained. Also general information about the treatment of sewage sludge is explained.

In **chapter 3** the choice for producing PHA out of waste water is explained. Furthermore the results of the research are described. This results contain, efficiency of PHA production, required equipment, financial requirements, investment costs, break-even analyse, market analyse and the sustainability.

Chapter 4 contains the discussion points of the research.

Chapter 5 contains the conclusions of the research and the advice about the production of biodegradable plastic out of sewage sludge to Blauwzaam

2. Theoretical background

This chapter described the different waste streams in the region, the way of treating the wastewater and a general treatment of sewage sludge.

2.1 Different type of waste stream available in the region

According to Rolia Wiggelinkhuijsen there are five different waste streams in the region, which need further research to get the region more energy neutral. These five different waste streams are: Grass, wastewater, manure, dairy factory waste and willow wood.

2.1.1 Grass

According to the stocktaking done by Kirmit, 2010 there is in total 567 ha of roadside grass in Alblasserwaard-Vijfheerenlanden. Of the 576 ha the nature management organizations have about 200 ha. of road side grass and natural areas management of Alblasserwaard-Vijfheerenlanden have about 367 ha. of roadside grass. Contractors do the maintenance of grass. Table 2.1 sows the total amount of dry grass matter in the region Alblasserwaard-Vijfheerenlanden. Marien Verwolf is the chairman of the project: 'Groene Kracht'. Marien works for Waterschap Rivierenland. According to an interview with Marien:

- For the elimination of grass the Waterschap Rivierenland pays €500,-/ha/ year. This price includes the collecting costs, transport costs and converting costs
- There are no subsidies available for the conversion of grass to energy or another product, like paper. Also the legislation makes it hard to temporarily save the grass to for example use the grass juices as liquid fertilizer.

2.1.1.1 Energy potential

According to Marien Verwolf, the region of Alblasserwaard-Vijfheerenlanden contains a total amount of 1500 ton of dry matter out of 250 ha of roadside grass. The following products can be made out of roadside grass: paper products, energy, dry fibers, raw material for animal feed or green manure. 70% of the grass mowed by Waterschap Rivierenland is for the contractors and 30% is used as cattle feed.

2.1.2 Waste Water

To get a better insight about the wastewater treatment, Peter Willems has been contacted. He together with a technical expert provided all the required information. The choices for wastewater are to produce energy or biomass (PHA). At this time the sludge is used to produce energy from it. The sludge is fermented, which produces biogas. A technique used is called 'Combined Heat and Power plant' (CHPP), which is the use of a heat engine or power station to generate electricity and useful heat at the same time.

2.1.2.1 Energy potentiaal

The amount of wastewater from the area is 113 million m3 that is processed over 37 conventional wastewater treatment systems. The energy will come from the sludge generated from the wastewater. This sludge has a lot of potential for energy production or the Bioplastic production (PHA). Sewage sludge has relatively high net calorific value of 10-20 MJ/kg.

2.1.3 Manure

The first choice for the project was initially to produce energy from manure using a mono-digester.

The reason why the choice was rejected, was due to the interviews with the farmers. They indicated that manure was a highly valued product and where mon-digesters are used, the results are not positive. The farmers indicated that the efficiency levels of the digesters are very poor and can only function because of the grants from the government.

2.1.3.1 Energy potential

The area of Alblasserwaard-Vijfheerenlanden has 164 farmers, with an average of 90 cows, which produce milk for the factories in the area. The manure produced form the cows has a lot of potential for energy production, but the product itself has high value for the farmer, where it's used for fertilizing the land. The rest streams from the farms would be household waste, plastics (from grass), wood and animal waste.

2.1.4 Dairy factory

There are big dairy processing factories that have specific rest streams that are interesting to investigate for producing fertilizer. The idea for the factory is to use the rest streams from the cheese factory for producing fertilizer. The reason this subject was not chosen for the project is that these diary factories are not transparent about their rest streams quantities a qualities. They are not very interested in our ideas.

2.1.4.1 Energy potential

This is very unclear here, the dairy factories are non-transparent about their rest streams.

2.1.5 Willow wood

Another idea for the project was the use of biomass from the willows. The willows are pruned down for maintenance. This rest stream of biomass can be used to produce energy. The thought was that locals could use this wood for their heater to warm their house. The main point of concern was that it would cost more energy to collect and handle the wood then it would give from burning. Also wood heaters are not so much used anymore.

2.1.5.1 Energy potential

An estimated value 1 kg of willow will yield about 1 kWh of electricity. About 100 houses would need about 25 hectares of willow wood. A combined heat and power system with 100 kW electrical output will use 50 ha of willow wood harvested on a three year cycle. A power station generating 5 MW of electricity would need around 2.500 ha of willow wood.

2.2 Choice of focus

For this project, the choice to continue with the waste water treatment system is made, this because the first idea, generating biogas from manure, had, after having interviews with several farmers, no potential. The farmers did not see the manure as a waste but as a valuable residue, what they used as compost. After we came up with the conclusion that manure had no potential for this project, the other options were discussed with the famers. The farmers mentioned that their plastic waste was a problem for them and wanted to solve this problem. From that point we laid our focus more on the plastic waste streams of the farmers. We knew we could produce PHA (biodegradable plastic) from wastewater and from that point we continued to do research for this subject.

2.3 Treatment of wastewater – The technique

Wastewater contains contaminants including bacteria, chemicals and other toxins. Waste water treatment reduces the contaminants to acceptable levels to make the water safe for discharge back into the environment. Steps of the waste water treatment:

1. **Wastewater Collection:**
   Municipal administration, homeowners and business owners ensure that all the wastewater is collected and transfer to a central point, where it is brought to a treatment plant. Hygienic conditions are applied for the transportation.

2. **Odor Control:**
   Odor control is initiated at the treatment plant to ensure that the surrounding areas are free of the foul smell. The treatment consists of use of the chemicals.

3. **Screening:**
   Screening involves the removal of large objects (nappies, cotton buds, plastics, diapers, rags …). The solid wastes removed from the wastewater are then transported in landfill.

4. **Primary Treatment:**
   This involves the separation of macrobiotic solid matter from the wastewater. Primary treatment allows to the sludge and the solid waste to settles and they are removed and pumped out of the tanks for further treatment. The remaining water is then pumped for secondary treatment.

5. **Secondary Treatment:**
   Secondary treatment also called activated sludge process, is the process when sludge and air are add to the wastewater to ensure the further broken down of organic matter. The bacteria use the oxygen and consume the remaining organic matter. This process leads to the production of large particles that settle down.

6. **Bio-solidshandling**:
   This isthe solid matter that settle out after the primary and secondary treatment stages are transfer to digesters. The digesters undergo anaerobic digestion where methane gases are produced and there is a formation of nutrient rich bio-solids.

7. **Disinfection**:
   After the previous treatment, organism which can cause disease are still remaining. Chlorine and sodium hypochlorite are added to disinfected the wastewater. (Rinkesh, 2016)

2.4 Treatment of sewage sludge – The technique

Treatment of the sludge into biogas and fertilizer:

- **Digester:**
  The sludge is transferred to a fermentation tank, where anaerobic conditions are applied and at a temperature of 33 Celsius degrees. The bacteria convert the organic substances of the sludge into biogas.

- **Producing electricity:**
  The biogas produced is stored in a gasholder. The gas drives a generator, which produces electricity. The heat, which is formed, is again used to keep the fermentation process at temperature.

- **Drying of the sludge:**
  The sludge remaining after fermentation is collected in buffers. The sludge still contains lot of water. The water is removed from the sludge by using the centrifuges technique. Before

the sludge go to the machine, substances are added to the water to make the separation easier.

- **Burning:**
  After the dewatering, the sludge is temporarily stored in silos or a container. The dried sludge is transport to the place where they can be combust. The dried sludge can also use as a fertilizer. (Rijnlanden, z.d.)

Item	**Range**
Total dry solids (TS), wt %	0.5 – 8.0
Volatile solids (% of TS)	60 – 80
Grease and fats (ether-solube, % of TS)	6.0 – 30.0
Protein (% of TS)	20 – 30
Nitrogen (% of TS)	1.5 – 6.0
Phosphorus ($P_2 0_5$, % of TS)	0.8 – 3.0
Potash (K_2O, % of TS)	0 – 1.0
Cellulose (% of TS)	8.0 – 15.0
Iron (not as sulphide)	2.0 – 4.0
Silica (SiO_2, % of TS)	15.0 – 20.0
pH	5.0 – 8.0
Alkalinity (mg/L as $CaCO_3$)	500 – 1500
Organic Acids (mg/L as HA_c)	200 – 2000
Higher Heating Value BtU/lb	4000 - 7000

Table 2.2: Typical chemical composition of untreated primary sewage sludge (Rijnlanden, z.d.)

This kind of treatments proves that it is possible to produce biogas and fertilizer out of sewage.

3. Results

In this chapter the results of the research are described. These results include, production of PHA, required techniques, business plan, financial requirements, investment and sustainability issues.

3.1 Polyhydroxyalkanoate (PHA)

PHA is biogenic polyester that can be naturally accumulated in microbial cultures. More than 150 types of monomers can be combined in the PHA family to give different kinds of bioplastic with different properties. Bioplastic are biodegradable and they are produced from renewable resources, contrary to petroleum-based plastic, but they can have comparable properties. Bio plastics allows reducing CO_2 emission and it's a solution against source depletion. PHA can be used for packaging, horticulture and agriculture, medicine, electronics, automobile manufacture, textiles and construction and housing. (Thielen, 2014)

3.2 Process of PHA production

Production of polyhydroxyalkanoate (PHA) can be achieved in open, mixed microbial cultures. The sewage sludge of the wastewater treatment can be the source of carbon needed for the production of biopolymer. Around 300 different species of microorganisms can produce PHA. The process of producing PHA from activated sludge can be divided into 4 different steps:

1. **Fermentation**:
   The bacteria need a carbon source to produce PHA. The wastewater is rich in organic carbon. However, the microorganism cannot extract the organic carbon and they need to be fermented before. The fermentation consists of hydrolysis and acidogenesis steps that convert the organic matter into volatile fatty acid (VFA). VFA's are a suitable precursor for PHA synthesis. The optimal condition for a maximum VFA concentration is a temperature of 42°c, a hydraulic retention time of 4-5 days and a PH to 8-10.

2. **Enrichment**:
   The second step consists of the growth of bacteria and find into the activated sludge, that store the PHA. Indeed, the concentration of bacteria that store the PHA is not enough in quantity for production of biopolymer. During this process the environmental conditions that favours the growth and the survival of this bacteria are applied. Enrichment step is realized by doing cycles of high and low availability of either carbon or oxygen. This process is done in a sequencing batch reactor.

3. **Accumulation**:
   The biomass produced during the enrichment step is transferred into a separate reactor mixed with the VFA rich stream. These conditions allow a high storage of PHA into the bacteria.

4. **Recovery**:
   In this step, the PHA storage in the bacteria is maximal. The PHA granules need to be separate from the microbial cell material. It can be done by different process as solvent extraction, chemical digestion, enzyme digestion or mechanical extraction. The biopolymer is a powder or pellet. The material is viable for the manufacture of bioplastic products. (Autors, 01/2014) (Sing-key, 2013)

   The different variables playing a role into the PHA production yield are the aeration time, the sludge retention time, the concentration of VFA into the influent, the carbon/ nitrogen ratio and the cultivation time. This is one example of the yield achievable depending of the

variable: A sludge retention time of 5–10 days with an aeration time of 2 hours, 40% of volatile fatty acids in the influent and a carbon to nitrogen ratio above 25 g/g allow a production of 29% of the polymer from the weight of the sewage sludge. (Mokhtarani, 2012)

3.4 Capacity of Water treatment system Ablasserwaard

3.4.1 Efficiency

The input is 704.2m3/day, where a PHA production of 451.7kg is obtained. With these parameters the following efficiency can be obtained. (de Hart, Bluemink, Geilvoet, & Kramer, 2014)

Wastewater	1 m^3	100m^3	100.000m^3
PHA	0.64kg	64kg	64.000kg

Table 3.1: The efficiency of the process to produce PHA (de Hart, Bluemink, Geilvoet, & Kramer, 2014)

According to this table the efficiency is 64%.

3.5 Business Plan

In the business plan is explained which strategic alliances are made, what kind of business is set-up, which product will be sold, who got the ownership, the professional support, subsidies, to which consumers the product is sold and what the income statement is.

3.5.1 Strategic Alliances:

Blauwzaam will be cooperating with business Waterschap Rivierenlanden to create PHA out of sewage sludge. After producing the PHA beads, the beads will be converted into biodegradable plastic foil. An extruder machine will convert these beads into plastic foil. This machine can make foil with the width of 12 meters and the length of 50 meters.

This biodegradable plastic foil will be sold to the end customer: “the farmers” in the region of Alblasserwaard-Vijfheerenlanden.

3.5.2 The Business

Blauwzaam is an intermediary between businesses, but for this project Blauwzaam will, together with Waterschap Rivierenlanden and their wastewater treatment plant, work on the process of creating PHA. Blauwzaam will add value to this project by intermediating with businesses, such as farmers that could be potential customers. Also Blauwzaam will work together with the community of the farmers to make them aware of this project. The producer of the PHA will be Waterschap Rivierenlanden. To make the foil an extruder machine is needed. An investment is made to get this machine.

3.5.3 The Product

To create PHA, the wastewater treatment plant will be used. The PHA will be created out of sewage sludge and from this, there will be bioplastic beads generated. The beads need to be extruded into plastic foils. The plastic foils will be used in the agricultural sector in the region of Alblasserwaard-Vijfheerenlanden.

The first value added to the product is that it will decrease plastic waste, because the product is biodegradable and by this, it will not harm the environment.
A second value added is that the product will degrade underground or underwater in about six months (this is an assumption) (Kobs, 2016). When the plastic is used above ground, e.g. for covering

up the silage, it will last longer than the given time above. An assumption is that the biodegradable plastic will last in proper conditions between six months till two years. Further research to de degradability of the plastic is needed to confirm the biodegradability of the plastic.
A third value added is that the farmers will have a better sustainable image by using the biodegradable plastic foils, this because they will have less till none plastic waste.

3.5.3.1 Product list

In the first stage of product development their only will produced bioplastic foils for the agricultural sector, but with the plastic beads anything could be produced.

For this project the focus lays on the agricultural market in the region Alblasserwaard-Vijfheerenlanden. When the project is a success in the region and there is a profit made, then there could be the opportunity to expand the focus to a bigger region.

Also the expansion of the region could be an opportunity when the cost price of producing PHA is too high and could be decreased when producing on a larger scale. Presently, our product is before the introductory stage, because this document provides and advice on how the biodegradable plastic foil could be produced.

3.5.3.2 Unique features or proprietary aspects of product.

The reason that the bioplastic foil is so unique is that it is made out of sewage sludge with no ingredients added. This is better for the environment than plastic made of fossil fuels (The most plastics are made out of oils). The plastic is completely biodegradable and even could be used in the compost. By using the bio-plastic foil farmers will also be more sustainable and will have a decrease in their plastic waste. Therefore the farmers will be better people for the environment and will have less to no plastic waste anymore. The product will be feasible to use, because the degradability could be up to two years, when it is used above ground and water.

There are of course other businesses that produce bio plastics, but we are able to provide special made bioplastics just for the agricultural sector. Bioplastic foils made in the sizes and thickness as the farmer needs.

3.5.4 Ownership

Blauwzaam has authorized nine shares of common stock of which (100) are issued and outstanding. The following persons or organizations are significant owners of the project:

Name	# Share Held	% Ownership
BioBlue Solutions™	51	(51%)
Waterschap Rivierenlanden	30	(30%)
Blauwzaam	9	(9%)
Management team	5	(5%)
Seed ventures	5	(5%)

3.5.5 Professional support

BioBlue solutions will work together with Blauwzaam, Waterschap Rivierenlanden to create plastic foil for the agricultural market in the region Alblasserwaard-Vijfheerenlanden.

3.5.6. Board of Advisors

Rolia Wiggelinkhuijsen (Blauwzaam), Jan Versluis (Zuivelfabriek de Graafstroom) and Jan Verzuijlen (Deltafeed) have helped to decide to make the biodegradable foil for the agricultural sector.

Together with them is discussed which problem needed to be solved, which biomasses were available for use and what the opportunities were according to the agricultural sector.

3.5.7 Subsidy

Governmental subsidies, these can be provided by the government, e.g. Article 52 in the Dutch law could give us a subsidy for approximately 12 years if the product features the stated regulations about biodegradable plastics:

- The bioplastic needs to be biodegradable without harming the compost or slow down the compost. It also cannot harm the quality of the compost.
- The additional investments and/or subsidies will be used for the installation of the PHA fermentation plant.
- The subsidies could last for 12 years so with that income stream the maintenance of the machines can be paid.

3.5.8 Income statements

The sales will increase with the introduction of the new biodegradable plastic foil. It is planned to introduce the products roughly in November 2017.
The rate of sales will be different for this product; because the farmers will buy the biodegradable foil rolls ones a year. The rest of the year there will be no revenue stream from the foil rolls, only some farmers that buy one or two rolls extra. Some remaining PHA beads can be extruded into other products, which could be sold to different markets.

The cost of goods sold (COGS) will remain static, because there are no other materials added to produce the PHA and the plastic foil. Nevertheless, the production costs could decrease by producing in larger amounts. Selling and administration expense will increase in absolute euros, but decrease in percentages when sales will increase.

Research and development, will appear as a high percentage in the beginning of sales but will decrease as sales will increase and production will happen on a larger scale.

3.5.9 Financial Requirements

3.5.9.1 Population equivalent

To know how big the wastewater treatment plant need to be, the population equivalent (p.e.) needs to be known. According to Lenntech, 2016, which is an online calculator of the population equivalent of the region Alblasserwaard & Vijfheerenlanden is 344.350,58 p.e.

The population equivalent can be calculated with the COD in the wastewater in grams per m3 and the amount of nitrogen Kieldahl in grams per m3. COD stands for chemical oxygen demand in water.

According to Peter Willems from Waterschap Rivierenland the total amount of wastewater treated in the region Alblasserwaard & Vijfheerenlanden is 113 million m3. On daily bases this is 309.590 m3 of waste water.
According to van der Wijst & Groot-marcus, 1998**,** the average COD is 101 grams per m3 wastewater and the average amount of nitrogen Kjeldahl is 10,6 grams per m3 waste water. With this data the population equivalent of the region Alblasserwaard-Vijfheerenlanden is calculated

3.5.9.2 Investment of PHA production

To produce PHA Blauwzaam needs cooperation with the wastewater treatment plant in the region,

called “Waterschap Rivierenland”. For the production of PHA there will be a centrifuge, belt thickeners, PE*-installations, CHP* (+biogas boilers), sludge heat exchangers and a PHA* fermentation tank needed. (de Hart, Bluemink, Geilvoet, & Kramer, 2014). To produce usable bioplastic products out of the PHA an extruder is needed. To extrude the PHA into foil technical engineers are needed.

The stated costs are based on a population equivalent of 300,000.

VFA Fermentation

BUILDING COSTS		**EURO**
	VFA Fermentor	364,000
	Centrifuge (2)	260,000
	PE-installation	65,000
	VFA buffer (1)	50,928
	Pumps (2 per pump)	73,480
Electra and Process automation		173,042
Civil spaces		
	Centrifuge (2)	240,000
	PE-Installation	90,000
Incomplete		410,475
Total / investment		1,778,724

Table 3.2: The building costs for the VFA fermentation, ***Source spécifiée non valide.****.*

OPERATIONAL COSTS		**EURO**
	PE	364,000
	Maintenance	260,000
	Capital costs	65,000
	Electricity	50,928
Total	Annual costs	73,480

Table 3.3: The annual operational costs for the VFA fermentation, ***Source spécifiée non valide.****.*

The total investment cost for the VFA fermentation is €1,778,724 and the total operational costs (annually) are €73,480.

PHA-fermentation

Building costs		**EURO**
	Storage secondary slit	41,994
	PHA-production	48,252
	Settling tank	13,439
	Blowers (2)	43,904
	Centrifuge (2)	260,000
	PE-installation	65,000
	PHA-buffer	14,092
	Pumps (2 per pump)	99,438
Electra and process automating		117,224
Civil spaces		-
	Centrifuge (2)	240,000
	PE-installation	90,000
	PHA-production	121,931
Incomplete		346,582
Total / investment		1,501,856

Table 3.4: The building costs for the VFA fermentation, ***Source spécifiée non valide.****.*

OPERATIONAL COSTS		**EURO**
	PE	14,392
	Maintenance	30,037
	Capital costs	248,871
	Electricity	69,928
	Additional P-removement en slitproduction	25,445
Total	Annual costs (300,00 p.e.)	388,673

Table 3.5: The annual operational costs for the PHA fermentation, ***Source spécifiée non valide.***

The total investment cost for the PHA fermentation is €1,501,856 and the total operational costs (annually) are €388,673.

Extruder machine

Price		EURO
	Extruder machine	200,000
Building costs		
Civil spaces		
	Extruder machine	250,000
Total		450,000

Table 3.6: The building costs for the extruder machine, (Co., 12m wide plastic agricultural greenhouse film blowing machine, 2016).

OPERATIONAL COSTS		EURO
	Electricity	23,201
	Maintenance	30,037
	Employment salary	125,000
Total	Annual costs (300,00 p.e.)	178,238

Table 3.7: Operational costs for the extruder machine, ***Source spécifiée non valide., Source spécifiée non valide..***

The total investment cost for the extruder is €450,000 and the total operational costs (annually) are €178,238.

The total investment cost to produce biodegradable plastic foil is €3,730,580
The total annual cost to produce biodegradable plastic foil is €640,391

3.5.9.3 Costs of one roll

Chapter 3.5.9.2 show that the total investment cost for the production of biodegradable plastic foil is €63,730,580. These are the total costs for VFA fermentation, PHA fermentation and the extruding of PHA beads into plastic foil. For all the calculations, see appendix II.

According to *de Hart, Bluemink, Geilvoet, & Kramer, 2014* the price for 1kg of PHA is €5.30. According to the farmers one roll of plastic has a weight about 80 kg. So the price for one roll of plastic without the costs of extruding the PHA is €424. The investment costs without the extruder machine is €3,280,580. So the play break-even with this price 7,737 rolls need to be sold.

The total amount of plastic in kilograms that needs selling is 618,977.35 kg.

According to (Co., 12m wide plastic agricultural greenhouse film blowing machine, 2016) the extruder machine produce 600 kg of plastic per hour. To produce 618,977.35 kg of plastic foil the extruder machine needs to run for 1,032 hours. If the machine will run for 8 hours a day, the amount of days to produce the amount of plastic would be 129 days.
So the machine needs to run for 129 days to produce all the 7,737 rolls of plastic.

The price to extrude one roll of plastic is €23.03. This is calculated as follows:

One roll of plastic is 80 kg. The extruder machine produce 600kg of plastic per hour. So the machine can produce 7.5 rolls of plastic per hour or one roll of plastic (80kg) within 8 minutes.

Energy costs extruder machine per roll of plastic.
The energy cost for running the extruder machine for one hour is €22.49. The machine only needs to run for 8 minutes to produce one roll. So the energy cost for running the machine for one minute is €0.37. The energy cost for one roll of plastic is €3.

Maintenance costs extruder machine per roll of plastic.
The maintenance cost for running the extruder machine for one hour is €29.11. The machine only needs to run for 8 minutes to produce one roll. So the maintenance cost for running the machine for one minute is €0.48. The maintenance cost for one roll of plastic is €3.88.

Employment costs extruder machine per roll of plastic.
The employment cost for running the extruder machine for one hour is €121.17. The machine only need to run for 8 minutes to produce one roll. So the employment cost for running the machine for one minute is €2.02. The maintenance cost for one roll of plastic is €16.15.

So based on these different costs for extruding the PHA to plastic foil. The cost for extruding one roll of plastic is €23.03

The costs for producing one roll of biodegradable plastic is €447.03. This is based on the price for producing the PHA and the price for extruding the PHA beads into foil.

Costs for producing PHA = 5.30 per kg of PHA, so €424 for 80kg of PHA.
Costs for extruding PHA beads into one roll of plastic = €23.03.

Total cost for producing one roll of plastic = €447.03

3.5.9.4 Cost-effective selling price

So based on all the data above, the cost-effective selling price for one roll of biodegradable plastic exclusive VAT is €447.03. The cost-effective selling price for one roll of biodegradable plastic inclusive VAT is €540.90.

3.5.9.5 Break-even analyse

To play break-even there should be sold a total amount of 9,006 agricultural bioplastic foil rolls. Considering the annual demand of 2,250 rolls per year, it should take approximately four years to play break-even. If the 7,737 rolls (amount based on interviews) is sold there will be a loss of €462,300. This because 9,006 rolls is needed to be sold to be break-even. (CalcXML, 2016)

In figure 3.1 the fixed- and the variable costs are included and the price per unit is estimated at €447.03. The fixed costs including machinery is €3,730,580 and the variable costs based on 1 roll is €82.77, based on 9,006 rolls the total variable costs are €745,426.62. Operational costs are estimated at €640,391. According to these data the breakeven sales is 9,006 and the breakeven revenue is €4,025,952.18

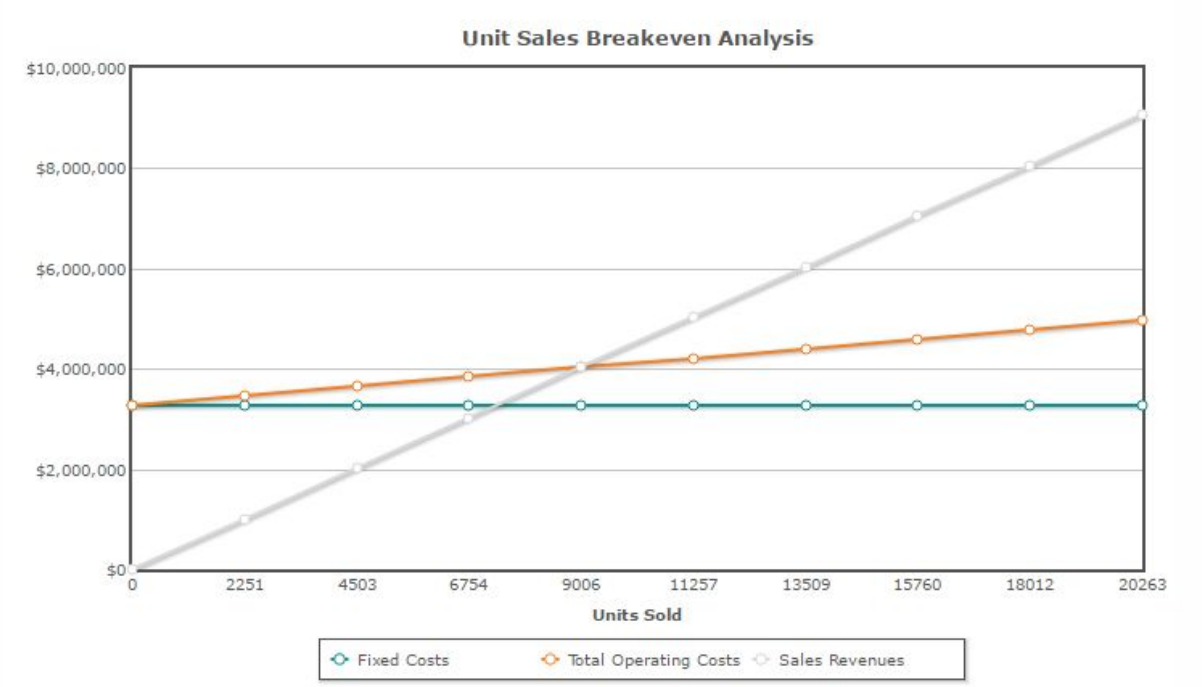


Figure 3.1: Break-even analyse for producing the biodegradable foil, (CalcXML, 2016)

3.6 Market analyse of PHA market.

This chapter describes an analyses of the market. First of all the global bioplastic market is described. After this the market for the Netherlands is described. Then the description of the market for the region Alblasserwaard-Vijfheerenlanden is described. In this analyse are also the results of the interviews shown, because these results are important for the market potential.

3.6.1 Plastic an bioplastic in the world

3.6.1.1 Global production of bioplastic

In figure 3.2 is shown the total production of biopolymers in 2014. The total production capacity of biopolymers is 1,697 Mt. According to IfBB (Institute for Bioplastics and Biocomposites) 663 Mt are biodegradable polymers and 1,034 Mt are durable polymers. In total 1,149 Mt of polymers are used for packaging, this is 67.70% of the total amount produced. Globally 107 Mt of plastic is produced for the Agriculture & Horticulture market, this is 6.3% (IfBB, 2015)

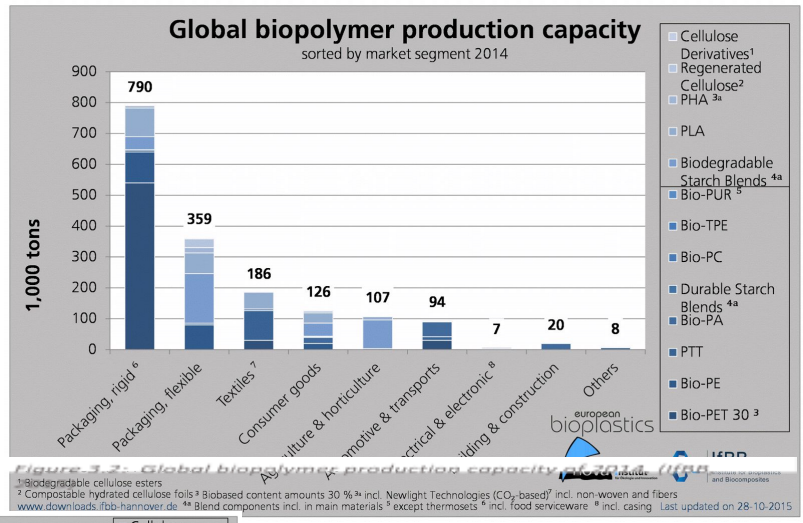


Figure 3.2: Global biopolymer production capacity of 2014, (IfBB, 2015)

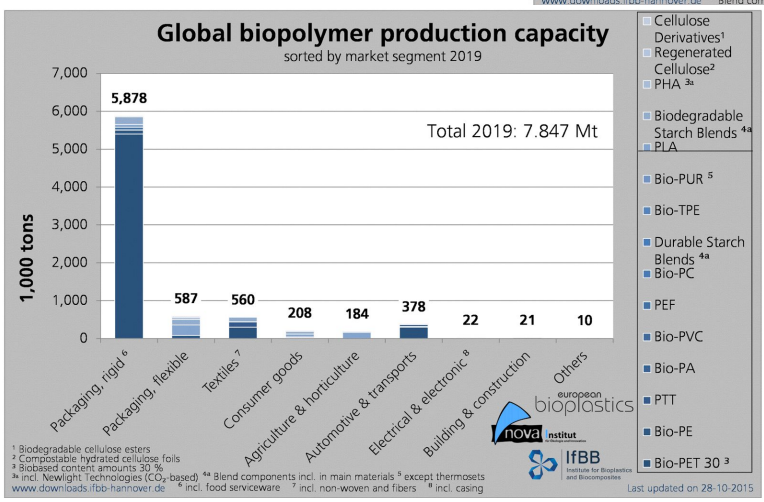


Figure 3.3: Global biopolymer production capacity of 2019, (IfBB, 2015)

According to the IfBB the global production of biopolymers is growing and in 2019 the total production will be 7,847 Mt. In 2019 6,465 Mt of the produced polymers would be used in the packaging market. This is an increase of 562% compared to 2014. The increase of the packaging is much higher compared to the agriculture (72% compared to 562%). Bio based, non-biodegradable plastics, such as bio based PE and bio based PET, are the main drivers of this growth.

Concluded out of this data is, that the polymers have the highest potential in the packaging market. Bioplastic is easy to use in the packaging market. The data illustrates that the packaging is going to be more resource efficient, which is driven by the customer demand. Nevertheless the other markets are increased as well, so this means that there is a market potential.

3.6.1.2 Global use of Plastic in agricultural market.

According to Grossman, 2015 the global agricultural plastic film market alone was estimated to be worth $5.87 billion in 2012. 40% of this is being used in mulching. China was estimated one of the

world's largest consumer of agricultural plastic films. China used around 60% of all the plastic. (Grossman, 2015)

3.6.2. Plastic and bioplastic in the Netherlands

According to de Hart, Bluemink, Geilvoet, & J.F. Kramer, 2014 there is a total amount of 1,800k of plastic in the Dutch market. The total amount of plastic waste is around 800k till 940k each year.

According to de Hart, Bluemink, Geilvoet, & J.F. Kramer, 2014 the bioplastic from waste water has a lower quality in comparison to the conventional bio plastics. Also because wastewater is seen as a waste stream in the Netherlands the bioplastic has lower potential on big scale, but more potential in niche markets. The agricultural market is an example of a niche market in the Netherlands. According to the report the agricultural market has great potential, because the quality (homogeneity of the biopolymer and guaranteed product) of the plastic wouldn't be necessary.

In the Netherlands there is around 48,000 kg of plastic waste in the agricultural market. These plastic waste is inclusive the sand on the plastic. Around 40% of the total amount is sand. The most common products in these waste streams are agricultural foil, horticultural foil and flowerpots. (De Hart, Bluemink, Geilvoet, & Kramer, 2014)

According to the same report it isn't known what the percentage this waste stream is compared to the total amount of used plastic. A rough assumption can be made if the ratio between the total amount of plastic and the total amount of plastic waste in the agricultural market is the same as the plastic market of the whole Netherlands. According to this assumption the total plastic market would be around 100k. So in total there could be 100k of biodegradable plastic produced and used in the agricultural market of the Netherlands

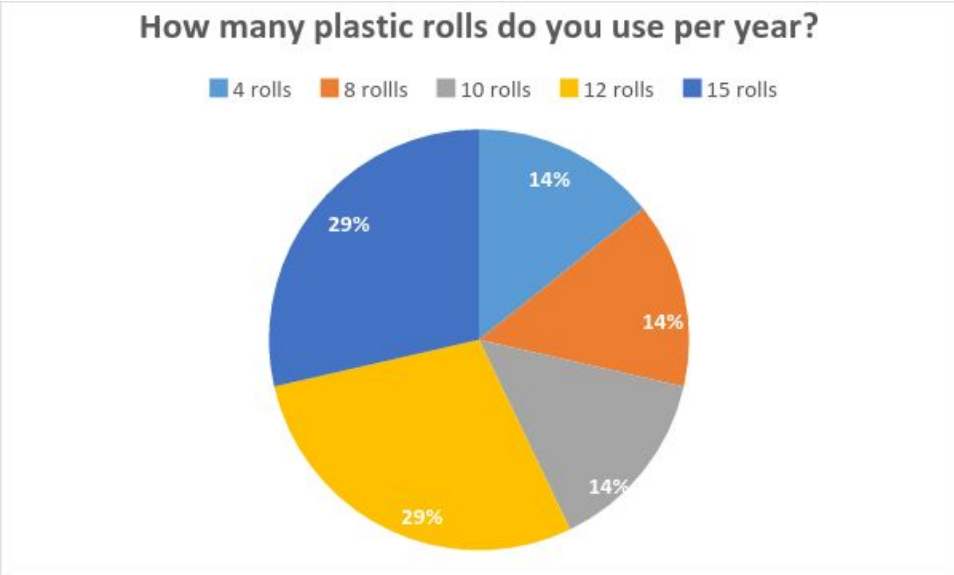
3.6.2.1 Expectations of the PHA market.

The European market for bioplastic will grow 20% per year. This is due to a growing demand for sustainable solutions and the increasingly development of new materials/biomass. The drivers of this market growth include cost reduction, sustainability, innovation and commodity.

Expected is that the global production of bio plastics has increased in 2016 to 5,800k. The not biodegradable bioplastic will face a bigger growth than the biodegradable bioplastic. The market for not biodegradable bioplastic will grow by 600% in the period of 2011 to 2016 while the market for biodegradable bioplastic will grow with 60% in the period of 2011 to 2016. Each year the market of bioplastic will increase with 30% - 40% till 2016. Expected is that the share of PHA is increased to 2.5% by 2016. Which is converted to a production of 145k kg PHA per year. Expected is that Asia and South-America will play a big role in the production of bio plastics. Europe will be an interested development location, this due to the fact that Europe use a lot of bio plastics. (De Hart, Bluemink, Geilvoet, & Kramer, 2014)

3.6.3 Plastic use in Alblasserwaard & Vijfheerenlanden

According to Jan Versluis (Zuivelfabriek De Graafstroom) there are 150 dairy farmers in the region Alblasserwaard-Vijfheerenlanden and each of these dairy farmers use plastic for silage or wrapping up the grass. Interviews with the dairy farmers are done to get to know how many plastic the farmers use and according to these interviews the most farmers use about 12 till 15 rolls each year. These rolls have different sizes and the most common sizes are 12m width x 50m length and 150 µm in thickness and 14m width x 50m length and 150 µm in thickness. In graph 3.1 the total amount of



plastic rolls used for the different farmers is shown. The amount shown are the amounts the farmers buy each year, also one of the interviews was with Jan van Zuijlen. Jan works for DeltaFeed and buys plastic rolls for 20 – 25 farmers each year.

According to the interview an assumption can be made. This assumption is that on average the farmers use about 12 rolls each year. In the interviews with farmers, the farmers assumed that on roll of plastic foil weights about 80kg till 100kg. In total there are 150 dairy farmers in the region. So, calculated with these assumptions the total amount of plastic used in the region Alblasserwaard-Vijfheerenlanden is between: 144,000 kg and the maximum amount, based on the assumptions, is: 180,000 kg of plastic used.

Calculations
Minimum: 12 rolls x 150 farmers x 80 kg/per roll = 144,000 kg of plastic used.
Maximum: 12 rolls x 150 farmers x 100kg/per roll = 180,000 kg of plastic used.

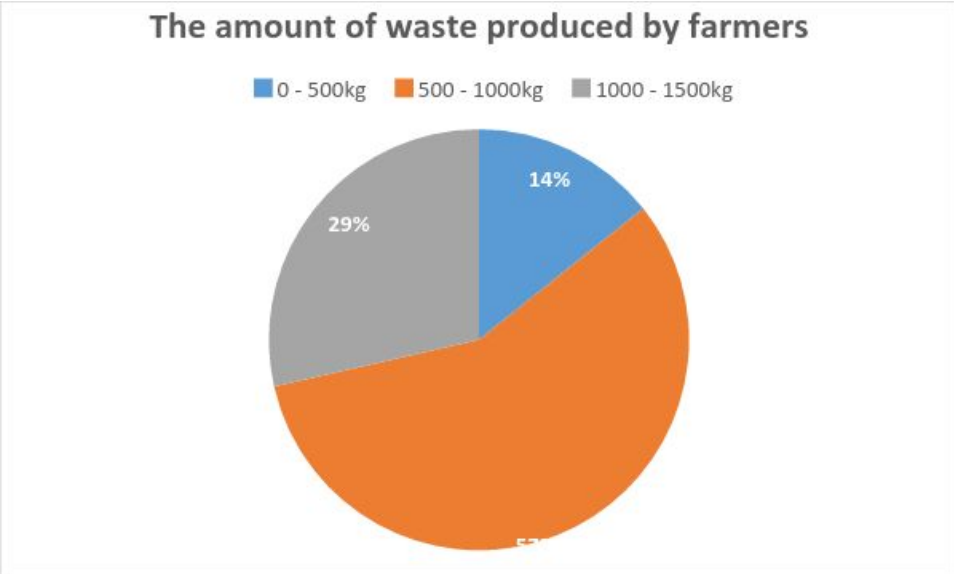
3.6.3.1 Plastic waste in Alblasserwaard & Vijfheerenlanden

The total amount of plastic waste in the region Alblasserwaard & Vijfheerenlanden is based on the interviews with farmers. The farmers have different amount of waste. The total amount of waste is

Graph 3.1: How many plastic rolls do the farmers use per year

based on calculations with an average of plastic waste the farmers produce. Also some assumptions are made.

In graph 3.2 the total amount of waste farmers produced is shown. As shown the amounts are different. The most farmers have 500Kg till 1000kg of plastic waste. According to the interviews the average amount of waste per farmer is around 1000 kg each year.



Graph 3.2: The amount of waste produced by farmers

To calculate the total amount of plastic waste the average kg of waste are used and this amount is multiplied by 150 dairy farmers.

The total amount of plastic waste in the region is: 150,000 kg of plastic waste.

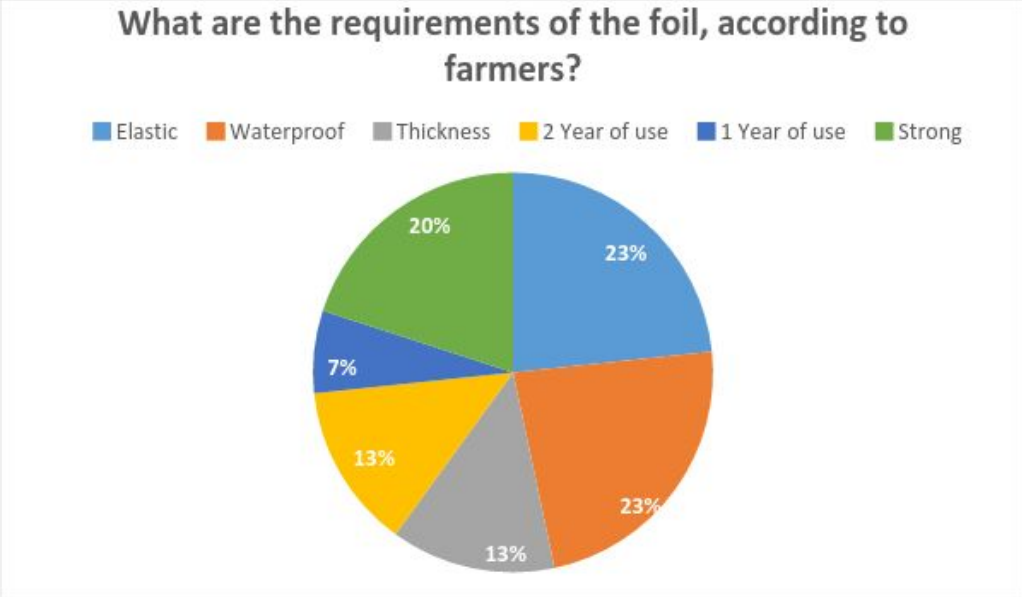
Calculation: 150 dairy farmers x 1000 kg = 150,000 kg of plastic.

When farmers are going to use biodegradable plastic, they will reduce the total amount of plastic waste. The total amount of plastic waste won't be zero, because not all the farmer will buy the biodegradable plastic. Farmers have different reasons to not buy the biodegradable plastic.

3.6.3.2 Requirement for the plastic from farmers

The dairy farmers have some requirements for the foil, this because the foil needs to be of high quality. The reason for this is, that the plastic protects the food for the cows. The cows produce the milk the farmers sell. So these foods need a good protection during the year. According to the interviews the farmers have different requirements for the plastic.

In the graph 3.3 are requirements for the foil shown. This diagram shows that the elastic, waterproof and thickness are the most important requirements. The plastic needs to be elastic, because when it is too rigid it will tear in pieces when farmers cover-up the plastic. Also the plastic needs to be resistant to different weather conditions. When it is not waterproof the food will rot and the cows can't eat it anymore. Another important requirement is the degradability of the foil; this is because the farmers use the plastic for more than one year. Farmers use the good parts of the plastic in the next year. The plastic from the previous year is an under layer for the new plastic.



Graph 3.3: What are the requirements of the foil according to the farmers?

3.6.4 Market price of PHA

The current market price for pure PHA, produced by the conventional production method from glucose, starch or vegetable oil, is set in 2013 at €4, - to €5, - per kg.

Market prices of different bioplastic are show in the table.

Type of plastic	Market price
Polyethylene	€1.00 - €1.50
Polystyrene	Till €2.00
Polylactide	€1.50 - €2.00
Starch Plastics	€2.00 - €4.00
Cellulose plastics	€4.00 - €5.00
Bio-PE	€1.50 - €2.25
PHA	€4.10 - €4.70

Table 3.8: Market prices for different kind of plastics, (de Hart, Bluemink, Geilvoet, & Kamer, 2014)

According to de Hart, Bluemink, Geilvoet, & Kamer, 2014 biopolymers will be applicability when the PHA market price is below €3,- per kg, this also the desired market price. In the long run the market price for PHA will be around €2,- per kg (de Hart, Bluemink, Geilvoet, & Kramer, 2014). This price is needed to compete with other bio plastics. As PHA can be produced at the same price aspolypropylene (€1,30 – €1,55) or polystyrene (€1,75 – €1,90) than it is possible to take over the whole market. It is possible to take over the market, because PHA has similar properties the other biodegradable plastics.

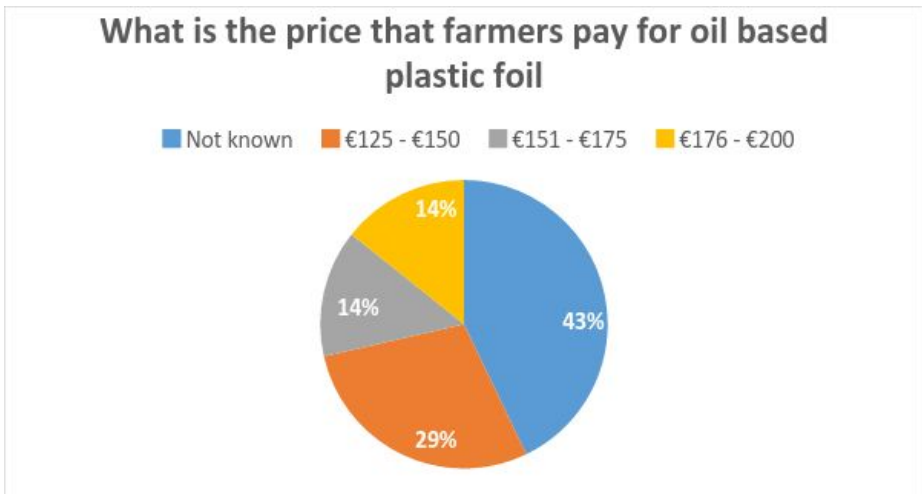
According to de Hart, Bluemink, Geilvoet, & Kamer, 2014, the break-even price for producing 1 kg of PHA out of sewage sludge is €5.30. These costs are divided as follows:

Parameter	Unit	Costs
VFA-fermentation:	Euro/kg	2.70
PHA-fermentation	Euro/kg	2.10
Overall costs	Euro/kg	0.50
Total	Euro/kg	**5.30**

Table 3.9: Price for 1kg of PHA., (de Hart, Bluemink, Geilvoet, & Kamer, 2014)

With this break-even price the plastic foil can be calculated. If 1 kg of PHA is €5.30, the price for 80kg of plastic will be: €424. The total price of one plastic roll is €447.03. This because of the cost to extrude the PHA beads.This price is way higher than the oil based plastics. According to Jan van Zuijlen from Deltafeed, one roll of plastic foil (12m x 50m x 150 µm) costs €136 exclusive of VAT and Inclusive the VAT the price is €164.56

In graph 3.4 the prices for the plastic foil are shown. These prices are based on the interviews with farmers. What this diagram shows is, that the farmers pay different prices. Also most of the farmers do not know what they pay for one roll of foil. These farmers are connected with the purchasing group of Deltafeed. Besides these farmers the other farmers pay at least €125 till €200. This depends on the size of the plastic foil.



Graph 3.4: What is the price that farmers pay for oil based plastic foil

Graph 3.5 shows what the farmers currently pay for their plastic. Diagram … shows what the farmers are willing to pay for the biodegradable plastic. According to this diagram there is a different in the farmers. Most of the farmers (43%) want to pay the price they also pay for the oil based foil. The reason for this is, that currently the foil is also recycled and the farmers don't need the biodegradable foil. They aren't willing to pay more. But also 43% of the farmers are willing to pay €251 till €300. The bad thing is, that the price of the biodegradable plastic is €447.03. The good thing is, that the farmers want to pay more for the biodegradable plastic. So when the technology is better develop and the processes need less cost than the biodegradable plastic would be feasible.

According to the interviews farmers want to buy the biodegradable plastic if the price is almost as

low as the price for oil-based plastic. Another reason for the farmers to not buy the biodegradable plastic is, that the plastic waste they have right now is also be recycled. So they already think they are very sustainable, and don't see the problem the much more for the biodegradable plastic.

3.6.5 Conclusion of market analyse

The total production of biopolymers in the world will increase from 2014 till 2019 with 562%. 82.4% of these biopolymers will be used in the packaging market. Only for about 2.35% will be used in the agricultural market.
The market for not biodegradable bioplastic will increase much more in the period from 2011 till 2016 than the market for biodegradable bioplastics (600% compared to 60%).
In the Netherlands there is around 48k kg of plastic waste (40% is sand) in the agricultural market, but in Alblasserwaard-Vijfheerenlanden is around 150,000 kg in total.
The price for PHA is too high. According to de Hart, Bluemink, Geilvoet, & Kamer, 2014, the price of PHA is €5.30 per kg of PHA. With the extradition costs the price for one roll of biodegradable plastic will be €447.03. The price for oil-based plastic is around €136 till €159 exclusive VAT. So the price for biodegradable plastic is 328.90% till 272.58% higher than oil-based plastic.
According to the interviews with the farmers in the region this price is too high. So conclude out of this none of the farmers will buy the plastic foil. So the production needs to be cheaper to get a cheaper end product. Because Farmers want to pay more for the biodegradable plastic waste, but not this much. Also the farmers already think they are very sustainable, because they recycle their plastic waste.

3.7 Sustainability

The concept of sustainability has been first created in the Brundtland Report in 1987. It defines sustainable development, as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." A sustainable development meets the three pillars: planet, people and profit.

In this part of the report, sustainability of the project will be discussed. In the first part, the long term and short term of the project will be described, then the strategy with people, place, price and promotion will be developed and finally the possible barrier and the solution to get over them is outlined.

3.7.1 Short term

Nowadays, the farmers use conventional plastic foil to cover up grass to protect them to the wind, sun or rain. The idea is to produce biodegradable PHA from sewage sludge of the wastewater treatment plant of the region to produce this foil.

3.7.2 Long term

The long-term goal of this project is to make the region of Alblasserwaard-Vijfheerenlanden more energy neutral. Use biodegradable plastic from a waste stream for the agriculture field increase the sustainability of the region. Indeed, this process allows decreasing the use of fossil resources. Less energy is required for the disposal of the plastic because the plastic decompose by itself.

3.7.3 Sustainable strategy

- People: The strategy is to involve the people into our project. The farmer should visit the wastewater treatment plant to see how the plastic is produced. Moreover, the production of PHA may create opportunities for new job placement in the area.
- Place: the production of the PHA will be produce in the region Alblasserwaard-Vijfheerenlanden in the wastewater treatment. The extrusion will be also done in the region and the product is going to be sold to the farmers in the region. This allows a local process, which will decrease the cost of distribution and transport.
- Price: The price of producing PHA is higher than the conventional plastic. Indeed, the investment cost is very high and the energy required is also important. The added sustainable value of the product can be an argument to pay more money.
- Promotion: Meeting with the farmers needs to be done to promote our product and explain that it can be benefit for their farms. The sustainable image can be improved.

3.7.4 Barriers

The main barrier is the high price of PHA production. Indeed, more money is needed to produce the biodegradable foil. The farmers are not willing to pay a lot more for they foil. However, the government can provide subsidies if we meet some requirements.

The other barrier is that the farmer does not want our product because they are not willing to change and they do not know the characteristics of the new plastic. We need to prove that the biodegradable plastic meets their requirement as the elasticity, the biodegradable time and the size.

4. Discussion points

The production of PHA is a big investment. For now, the production of PHA from wastewater treatment is not economically feasible. However, it is expected is that the development of the technology will allow a reduction of the cost in the future and that the price of the fossil fuel resources will also increase. This technology can be economically rentable in the future. Furthermore, other reports state that the production of PHA from sewage sludge is feasible for the technical aspect but it is not yet economical valuable.

The biodegradability of the foil needs to be tested before it is sold to the farmer. Indeed, one requirement is that the plastic begins to degrade after one year. This degradability of the plastic foil has not being tested yet and this characteristic is not sure to be achieved. Further experimentation is needed.
More PHA, than needed for the agriculture foil in the region, is produced from the wastewater treatment system. All the PHA can be used for foil production and the rest can be exported out of the region. The alternative solution is to use the PHA for other applications like packaging, production or new product like cups, cutlery, etc.

The amount of PHA produced that has been used, is found in the report (De Hart, Bluemink, Geilvoet, & Kramer, 2014). Indeed, the entire business plan has been based on this report and the data for the region is not available. The production of biogas can be done in the same time of the production of PHA. This biogas can be used to reduce the energy demand of the process and could save costs. The wastewater treatment plants, where the PHA production installation has to be set up, needs to be determined. More calculations about how much PHA we can produce from it needs to be investigated.

An LCA (Life Cycle Assessment) can be done to determine the impact of the biodegradable plastic on the environment and compare it to the conventional plastics.
From the financial aspect of the product the break-even points is 9,006 rolls. This amount needs to be sold in total to play break-even. This considers variable- and fixed costs. (see chapter 3.5.9.5). The amount of rolls needs to be sold divided by the annual demand is approximately seven years.

Seen from the best-case scenario, seven years will it take to play break-even. The worst-case scenario is that the farmers will not buy the rolls because of the high price.

The worst-case scenario is the most feasible one, at this moment, because the farmers will not be able or willing to pay twice as much for one roll of foil. Therefore, it is not economically feasible on the short term, but on a long term it could be feasible if needed research is be done.

5. Conclusions and Recommendations

5.1 Conclusion Financial Part:

As shown in the financial part (chapter 3.4.8), it will take approximately four (4) years to play break-even. The amount of rolls need to be sold is 9,006 and the demand is 2,250 rolls a year. In the break-even analysis are all the fixed- and variable costs included. With this there could be concluded that it is feasible over a long term. The first seven years there will be no profit, but after seven years there will be profit made. This could only be stated if all the farmers will buy the rolls. Considering the price per roll *(€447.03 excl.)* it is higher than the farmers pay now for the agricultural firm rolls (the price of regular rolls: 136 to 159 euro). The price is almost twice as high.

Assuming, the price per roll will be too high for the farmers to buy and through this assumption the following statement could be made:

"The farmers will not be willing and maybe not able to buy the bioplastic agricultural foils, because of the high price, therefore the bioplastic foils are, on the short term, economically not feasible."

Nevertheless, on a longer term the bioplastic foils could be a success, but to accomplish this there will be further research needed. Especially on decreasing the variable and fixed costs. A lower selling price is needed in the future for the bioplastic foils to be a success.

5.2 Conclusion Sustainable Part:

The sustainable part shows that the production of PHA from wastewater treatment system is feasible. However, in the aim to be more economically rentable, the yield of PHA production should be optimizing. Production PHA in a big scale can also reduce the costs.
The use of biodegradable plastic allows the reduction of the fossil fuel resource depletion. Moreover, the plastic don't have to be treating because it decomposes by itself. The process allows an improvement of the sustainability of the region.
The law and regulation make hard for the new bio-based technology to compete with the well develop fossil fuel technology use at this moment.

5.3 Advice/Recommendations

Producing PHA out of sewage sludge is for now economically not feasible, but it is not a call to stop with this. Our advice is to keep researching for the discovery and the development of more advanced techniques. With this the cost price could go down and this could raise the feasibility of PHA from sewage sludge.
But for now keep researching and also look at the alternatives: Biogas and fertilizer.
These resources could also be produced within the treatment of wastewater.
Another option could be to produce PHA products that are normally more expensive and need less plastic to produce (instead of foil rolls of 80 kg), for example: non-disposable coffee cups or Tupperware products. You could think of anything that is made of plastic.
Concluding, for now it is economically not feasible to produce PHA and sell it because the prices will be too high for the consumer market. This does not mean that the research has to stop too. Our advice is to keep researching and maybe in the future there are options to produce PHA in a less expensive way.

6. Literature list

Autors, 13. Polyhydroxyalkanoate (PHA) production from sludge and municipal wastewater treatment. Water Science & Technology. January 2014.

Blauwzaam. (2012, juni 14). *Blauwzaam gesteund door 2 Green Deals met de overheid*. Retrieved from www.blauwzaam.nl: http://www.blauwzaam.nl/content/pijlers/nieuws/detail/blauwzaam-gesteund-door-2-green-deals-met-de-overheid

Blauwzaam. (2016). *Mission*. Retrieved from www.blauwzaam.nl: http://www.blauwzaam.nl/content/pijlers/blauwzaam/missie/

CalcXML. (2016). *How many units do I need to sell to breakeven?* Retrieved from www.calcxml.com: https://www.calcxml.com/calculators/breakeven-analysis?skn=#results

Co., L. R. (2016). *12m wide plastic agricultural greenhouse film blowing machine*. Retrieved from www.alibaba.com: https://www.alibaba.com/product-detail/12m-wide-plastic-agricultural-greenhouse-film_60528435874.html?s=p

de Hart, N., Bluemink, E., Geilvoet, A., & Kramer, J. (2014). *Bioplastic uit Slib Verkenning naar PHA-productie uit zuiveringsslib.*Amersfoort: STOWA (Stichting Toegepast Onderzoek Waterbeheer).

Grossman, E. (2015, April 6). *How can agriculture solve its $5.87 billion plastic problem?* Retrieved from Greenbiz.com: https://www.greenbiz.com/article/how-can-agriculture-solve-its-1-billion-plastic-problem

IfBB. (2015). *Global biopolymer production capacity sorted by material grade*. Retrieved from ifbb.wp.hs-hannover.de: http://ifbb.wp.hs-hannover.de/downloads/index.php?site=Statistics&nav=5-2-3-0-0

Kirmit, Ç. (2010). *Biomassa als duurzame energiebron voor de Ablasserwaard-Vijfheerenlanden.*Waddinxveen.

Kobs, T. (2016, December). PHA. (BioBlue Solutions, Interviewer)

Mokhtarani, Nader, Ganjidoust, Hossein and Vasheghani Farahani, Ebrahim. Effect of process variables on the production of Polyhydroxyalkanoates by activated sludge. 2012.

Rijnlanden, z.d. Hoogheermraadshap de stichtse. Energie opwekken uit slib. http://www.hdsr.nl/. [Online]

Rinkesh. What is Wastewater Treatment? conserve energy future. http://www.conserve-energy-future.com/process-of-wastewater-treatment.php 2016.

Sing-Key., John. Resource Recovery Potential of Wastewater Treatment: Biopolymers. 2013. Thielen, Dr. Michael. BIOPLASTICS. 2014.

Thielen, Dr. Micheal. BIOPLASTICS. 2014.

Watkosteenkilowattstroom. (2016). *Vaste kWh prijzen*. Retrieved from www.watkosteenkilowattstroom.nl:

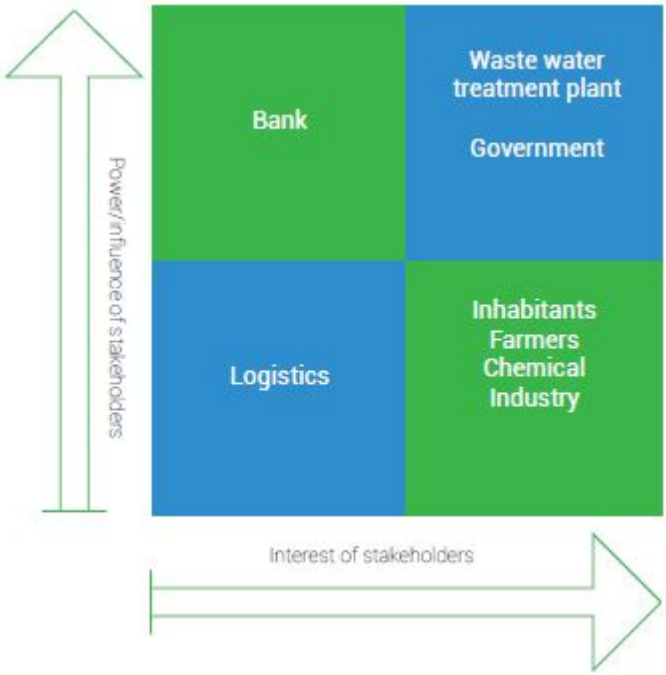
http://www.watkosteenkilowattstroom.nl/wat-kost-stroom/

Appendix

IStakeholder analyses

Name stakeholder	Type	Interest/Impact on						
		Finance	Environmental	Legislation	Reputation	Want to change	Research	Innovation
Waste water treatment plant	Partner/Waterschap rivierenland	++	++	+	++	++	++	+
Inhabitants	Consumer/supplier	+	+	-	+	-/+	-	+
Government	Government	++	+	++	++	+	+	-/+
Logistics	Logistics	+	-	-/+	+	-	-	-
Bank	Investor	++	-	+	+	+	+	-/+
Farmers	Consumer	+	++	-/+	+	++	++	+
Chemical industry	Client	++	+	+	++	++	+	+

++ = Very big interest or impact on the project.
+ = Big interest or impact on the project.
-/+ = Normal interest or impact on the project.
- = Low interest or impact on the project.



	Which stakeholders	Way of communication/involvement (strategy)
Key players	Government waste water treatment	Government = legislator, investor Waste water treatment = partner
Meet their needs	Bank	Bank = investor
Show consideration	Inhabitants Farmer Chemical Industry	Inhabitants = not Farmer = Supplier, consumer Chemical Industry = small partnership
Least important	Logistics	Logistics = partner

I.I Explanation of the stakeholders analyse

These are the stakeholders regarding the wastewater treatment plant. In earlier chapters in the report there is been told about this subject. In the process of picking the right stakeholders, there is been looked for if the stakeholder would be interested and if they would have any impact on the project.

Government and wastewater treatment plant
The stakeholders like the government and the wastewater treatment plant are the key players, because the government has rules and regulations so they must agree and approve. Furthermore, the government could be an investor. They could invest in the way of subsidizes. The wastewater treatment plant is the main stakeholders, because there will be a cooperation with this player. The sewage sludge is going to be used for producing PHA. (see chapter 2.3).

Bank
The bank could also be an investor. The bank has less interest in the project, if there is a good business plan the bank could be agree with investing money.

Inhabitants and farmers
The inhabitants and the farmers could be consumers. These are stakeholders that could use the finished products. For example, for the farmers there could be foil produced and for the inhabitants the PHA could be used to produce packaging.

Chemical industry
The chemical industry might have more suitable rest streams (with higher amounts of fatty acids) and they might store these fatty acids in separate tanks on the site. This is why the chemical industry is also an important stakeholder of this project.

Logistics
The stakeholder logistics could partly be handling the storage of the produced plastics and the transportation of the PHA. In the Dutch cities every street has storm water pits. These pits are cleaned once in a time and the residues have to go somewhere to be reused or to be destroyed. But in our opinion the residues of these pits could also be used for the production of PHA.

IICalculations of financial requirements

Investment cost without extruder machine:
€1,778,724 + €1,501,856 = €3,280,580

Total rolls that need to be sold:

€3,280,580 / €424 = 7,737 rolls.

Total amount of plastic in the region Alblasserwaard-Vijfheerenlanden:
This is calculated based on the average weight of one roll of plastic, which is 80kg. So 7,737 (total amount of rolls) x 80kg (average weight roll) = 618,977.35 kg.

Total amount of hours to produce the total amount of plastic:
600kg per hour / 618,977.35 kg(total amount of plastic) = 1,031.628 hours.

Amount of days the machine needs to run:
1,031.628(total hours) / 8 (total hours a day) = 128.96. Is 129 days.

The amount of minutes of running the machine to produce one roll:
600kg / 60 minutes (1 hour) = 10kg per minute. One roll is 80kg so, 80kg / 10kg per minute = 8 minutes.

Energy cost for running the extruder machine for one hour:
23,201 (total energy costs / 1,031.628(hours machine running = €22.49 cost per hour.

Energy cost for running the extruder machine for one minute:
€22.49 (cost for one hour) / 60 minutes = €0.37 costs per minute

Energy cost for running the extruder machine for one roll:
€0.37 (cost per minute) x 8 minutes = €3 costs per roll.

Maintenance cost for running the extruder machine for one hour:
30,037 (total maintenance costs / 1,031.628(hours machine running) = €29.11 cost per hour.

Maintenance cost for running the extruder machine for one minute:
€29.11 (cost per hour) / 60 minutes = €0.48 costs per minute.

Maintenance cost for running the extruder machine for one roll:
€0.48 (cost per minute) x 8 minutes = €3.88per roll.

Maintenance cost for running the extruder machine for one hour:
€125,000 (total employment costs) / 1,031.628(hours machine running) = €121.17.cost per hour.

Maintenance cost for running the extruder machine for one minute:
€121.17 (cost per hour/ 60 minutes = €2.02 cost per minute.

Maintenance cost for running the extruder machine for one roll:
€2.02 (cost per minute) x 8 minutes = €16.15 cost per roll.

Total cost for extruding one roll of biodegradable plastic:
€3 (energy costs) + €3.88 (maintenance costs) + €16.15 (employment costs) = €23.03

Annual demand of rolls per year in the region Alblasserwaard-Vijfheerenlanden
180,000 kg of plastic used in the region / 80 kg (weight one roll) = 2,250 rolls per year.

Total amount of years to play break-even
9,006 / 2,250 (Annual demand of rolls per year) = 4.002 years, so 4 years

Variable cost per roll
€640,391 (total annual costs) / 7,737 (total amount of rolls) = €82.77

Total variable cost
9,006 (amount of rolls to play break-even) x 82.77 (variable cost per roll) = €745,426.62

IIIInterviews with farmers

III.I Interview set-up

We are students at the Avans University of Applied Science at Breda. At this time we are doing a research together with Blauwzaam. The research is about how we can produce biodegradable foil, for the agriculture, out of sewage sludge.

For this research we ask your help. Below there are 10 questions formulated about the biodegradable foil. Answering the questions will take about 5 minutes of your time. Thank you in advance for your help.

1. **How many rolls (square meters of plastic) of silage plastic do you use on average in one year?**
2. **What requirements do you have for the foil you use?**
3. **Do you buy your plastic rolls in a collective way or do you buy the foil individually? And why?**
4. **Do you have plastic waste? And if yes, how much plastic waste (in kg) do you have each year?**
5. **How do you process the plastic waste?**
6. **How much do you pay for this process of plastic waste?**
7. **How much do you pay for each roll of plastic you use?**
8. **Have you ever considered about using biodegradable foil to cover up the silage? Why?**
9. **Are you interested in the biodegradable foil? Why or why not?**
10. **What is the maximum price you want to pay for a roll of plastic foil?**

III.II Interview with the farmer Erwin Zaal from the farm Hijkoop - zaal

1. **How many rolls (square meters of plastic) of silage plastic do you use on average in one year?**

No average I use about 8 rolls of plastic foil. This is about 4000m2, because 1 roll is 500m2 (14m width x 35m length). Every year I buy my plastic in February.

2. **What requirements do you have for the foil you use?**

The foil need to be strong enough. With this I mean, the foil can't tear when I'm pulling the foil on the silage. Also the foil needs to be waterproof. And the size of the foil is important.

3. **Do you buy your plastic rolls in a collective way or do you buy the foil individually? And why?**

I buy the foil in a collective way, because the price is better when farmers buy their foil together. Also it is easier for me, because Deltafeed search for the best price. I only need to give him the information about the foil (sizes, colour, etc.).

4. **Do you have plastic waste? And if yes, how much plastic waste (in kg) do you have each year?**

Yes i have plastic waste. The plastic I buy is also my plastic waste, so the 8 rolls are also my plastic waste. Each roll weighs about 80kg till 100kg. This is at least 640kg of plastic waste, and at most 800kg. The plastic waste isn't very clear, because there is also sand on the plastic.

5. **How do you process the plastic waste?**

I bring the plastic waste the a local place. At this place there is a container. This container is owned by a contractor who wants the plastic for free. So I collect all mine plastic waste and dump it in his container.

6. **How much do you pay for this process of plastic waste?**

It is for free. The contractor wants the plastic and we don't have to pay for it.

7. **How do much do you pay for each roll of plastic you use?**

I don't know how much I pay for the plastic, because we buy the plastic in a collective way. The price isn't known for us.

8. **Have you ever considered about using biodegradable foil to cover up the silage? Why?**

No, I have never considered using the biodegradable foil. The reason for this is, that today the plastic is also recycled by the contractor. And I think this kind of foil doesn't exist. I also think it is more expansive than the plastic we use now.

9. **Are you interested in the biodegradable foil? Why or why not?**

Yes if the foil got the requirements I put at question 2. But also if it's biodegradable in about 3 years. This because I use the foil for more than one year. The way I cover up my foil is to use first the old foil. After I reused the old foil is use a layer of new foil. So the foil need to be in good state for about 2 years.

10. **What is the maximum price you want to pay for a roll of plastic foil?**

The maximum price I would pay for the foil is around €150 till €200. I think this is the average price for a roll of plastic. If the rolls of plastic is €300 it is too much, because we can process the plastic for free.

III.III Interview with the farmer from the farm Koolhoeve

1. **How many rolls (square meters of plastic) of silage plastic do you use on average in one year?**

Every year I buy 2200 square meters of plastic foil each year. I buy 2 rolls of 12m x 50m and 2 rolls of 10m x 50m the thickness is 150 um

2. **What requirements do you have for the foil you use?**

The foil need to be useful for 1 year.

3. **Do you buy your plastic rolls in a collective way or do you buy the foil individually? And why?**

I buy the plastic foil in a collective way, because this is better for the price. When we buy the plastic together than we get some discount on the products.

4. **Do you have plastic waste? And if yes, how much plastic waste (in kg) do you have each year?**

I have around 400 kg of plastic waste each year. There is also sand on the plastic waste.

5. **How do you process the plastic waste?**

I collect all my plastic waste at my farm. When I can't collect any plastic waste I will bring this plastic into the container at the location. The contractor will take the plastic for free to recycle it.

6. **How much do you pay for this process of plastic waste?**

Nothing

7. **How much do you pay for each roll of plastic you use?**

I don't know the price of one roll of plastic, because the purchasing group buys these rolls and the price is secret.

8. **Have you ever considered about using biodegradable foil to cover up the silage? Why?**

No, because till now it is going very well. The plastic is also recycled which makes it sustainable. Also the prices of the oil based foil are lower, so it is economically better to buy these foils.

9. **Are you interested in the biodegradable foil? Why or why not?**

I have never thought about buying the biodegradable foil, so no. Also till today it is going well. (see question 8)

10. **What is the maximum price you want to pay for a roll of plastic foil?**

The maximum price I want to pay for biodegradable foil is €150. This because I think it is like the price for oil based foil. These prices are good for our economy.

III.IV Interview with the farmer Ruud Kooyman from the farm Delta Milk

1. **How many rolls (square meters of plastic) of silage plastic do you use on average in one year?**

In total I buy around 10 roll of plastic each year. The rolls have different sizes, because I buy 2 different sizes. One sizes is 11 m width x 50 m length and with the thickness of 150 um (6 rolls) The other size is like 11m width x 50m length and 4000um thick (4 rolls)

2. **What requirements do you have for the foil you use?**

The foil need to be elastic, strong, waterproof and I need to use it for minimum 2 years.

3. **Do you buy your plastic rolls in a collective way or do you buy the foil individually? And why?**

I buy the plastic foil in a collective way, because it is easier to do. I only need to give the information about the foil and Deltafeed search for the cheapest and best quality. Also it is better for the price, because when we buy the plastic in a collective way it will be cheaper.

4. **Do you have plastic waste? And if yes, how much plastic waste (in kg) do you have each year?**

Yes, I have. The amount of plastic that I buy each year is also the amount of plastic waste that I have. IF we say that 1 roll of plastic is about 80 till 100 KG than I have a total waste of at least 800kg.

5. **How do you process the plastic waste**?

I keep the waste at my own farm, and when I want to get rid of it, I throw it in an container and some contractor picks this plastic up.

6. **How much do you pay for this process of plastic waste**

Nothing

7. **How much do you pay for each roll of plastic you use?**

For the plastic foil I pay €125 till €145 per roll. This is based on the sizes (10m x 50m x 150um and 12m x 50m x 150 um)

8. H**ave you ever considered about using biodegradable foil to cover up the silage? Why?**

No, didn't know it exist.

9. **Are you interested in the biodegradable foil? Why or why not?**

Yes, only if the price and quality ratio is the same as the foil we have today. Also the degradability of the foil is important. Because I need the foil for more than 1 year.

10. **What is the maximum price you want to pay for a roll of plastic foil?**

The same prices as the price of the foil today. When the price is €30 more, than I also would buy this plastic.

III.V Interview with the farmer from the farm Krossbroeder

1. **How many rolls (square meters of plastic) of silage plastic do you use on average in one year?**

I buy 12 rolls each year. 6 rolls of 10m x 50m x 150 um and 6 rolls of under foil. This is the same size only thinner (4 um).

2. **What requirements do you have for the foil you use?**

The foil need to be strong, elastic and waterproof

3. **Do you buy your plastic rolls in a collective way or do you buy the foil individually? And why?**

I buy the plastic a local supplier. This is easier for me. I can buy the plastic at any moment.

4. **Do you have plastic waste? And if yes, how much plastic waste (in kg) do you have each year?**

Yes, about 960kg each year (12 rolls of 80kg).

5. **How do you process the plastic waste?**

Local compost.

6. **How much do you pay for this process of plastic waste?**

I pay €1.35 per cub of plastic. Total price I don't really know.

7. **How much do you pay for each roll of plastic you use?**

I pay €150 exclusive VAT per roll.

8. **Have you ever considered about using biodegradable foil to cover up the silage? Why?**

No, I never considered to buy biodegradable plastic.

9. **Are you interested in the biodegradable foil? Why or why not?**

Alleen als het goedkoper is en als het dezelfde eisen heeft als plastic van nu. Duurzaamheid zit er al in, wordt gerecycled

10. **What is the maximum price you want to pay for a roll of plastic foil?**

Zelfde als de huidige prijs. Paar tientjes verschil maakt niet uit, je hebt het toch nodig. Als er keuze is, gaat het naar de goedkoopste, of betrouwbaarste.

III.VI Interview with the farmer from the farm T.j. van der Ham

1. **How many rolls (square meters of plastic) of silage plastic do you use on average in one year?**

I buy 10 rolls of plastic foil each year. 6 rolls with the sizes of 14m width x 50m length and the thickness of 150 um, 2 rolls with the sizes of 12m width x 50m length, 2 with the sizes of 10m x 50m both with the thickness of 150 um.

2. **What requirements do you have for the foil you use?**

100% waterproof and elastic otherwise it will rip apart when covering up the grass.

3. **Do you buy your plastic rolls in a collective way or do you buy the foil individually? And why?**

I buy the plastic by myself. Most of the time at Agrifirm. Sometimes I buy one roll to less, so I need to buy one roll extra.

4. **Do you have plastic waste? And if yes, how much plastic waste (in kg) do you have each year?**

I have about 900 till 1000 kg of plastic waste each years.

5. **How do you process the plastic waste?**

I bring the plastic waste to a local container. Some contractor takes this plastic waste to recycle it.

6. **How much do you pay for this process of plastic waste?**

Nothing

7. **How much do you pay for each roll of plastic you use?**

The price isn't very important for me, because I need the foil. But most of the time I pay €195.

8. **Have you ever considered about using biodegradable foil to cover up the silage? Why?**

Yes, if it is degradable within 2 years, because 20% of the grass I don't use, so I use the plastic for more than one year.

9. **Are you interested in the biodegradable foil? Why or why not?**

Yes, because it is more sustainable and I also have a lot of plastic waste.

10. **What is the maximum price you want to pay for a roll of plastic foil?**

Maximum I want to pay €250 till €300 per roll.

III.VII Interview with the farmer Wim van Vuren from the farm Vuren / versluis

1. **How many rolls (square meters of plastic) of silage plastic do you use on average in one year?**

I usually buy around 15 rolls per year. The rolls have different sizes, 10m width x 35m length and 150 thickness and 12m width x 50 m length and 150 thickness

2. **What requirements do you have for the foil you use?**

Elastic, water and sunlight proof, strong, I need to cover it up without harming the plastic

3. **Do you buy your plastic rolls in a collective way or do you buy the foil individually? And why?**

Collective, because it is cheaper and I only need to say the amount and sizes I want to have.

4. **Do you have plastic waste? And if yes, how much plastic waste (in kg) do you have each year?**

The same amount of plastic that I buy, 15 rolls. 1 roll is around 80kg – 100 kg So in total 1200kg

5. **How do you process the plastic waste?**

A contractor want the plastic for free. So I collect all mine plastic waste and dump it in his container on a local and shared location.

6. **How much do you pay for this process of plastic waste?**

Nothing

7. **How much do you pay for each roll of plastic you use?**

He doesn't know, because he buys it collective.

8. **Have you ever considered about using biodegradable foil to cover up the silage? Why?**

No, because he never heard of it.

9. **Are you interested in the biodegradable foil? Why or why not?**

Yes, only if the price and quality is good. Also the requirements for the foil are the same. But if the price is higher he wouldn't buy it.

10. **What is the maximum price you want to pay for a roll of plastic foil?**

Same as the price of the rolls now. But if they buy it collective and it is cheaper then he would do it.

III.VIII Interview with Jan van Zuijlen from the purchasing group Deltafeed.

The questions below are answered based on information that is got from the interview with Jan van Zuijlen. Jan van Zuijlen is the person who buys the plastic for local dairy farmers in the region Alblasserwaard and Vijfheerenlanden. In total it only buys plastic for 20 till 25 dairy farmers, because these are cooperation with Deltafeed. Deltafeed is an purchasing group with in total 150 members and twenty purchasing groups. Jan van Zuijlen is working for Deltafeed and is responsible for the purchase of agricultural plastic. The agricultural plastic is used to cover up the silage. Jan van Zuijlen doesn't buy the plastic for wrapping-up the grass. This because the farmers itself don't wrap the grass but the contract workers do this.

What are the qualities requirements for the agricultural plastic?

According to Jan van Zuijlen there are a few qualities requirements for the plastic. The plastic need to be a bit elastic, because when it is too rigid it will tear in pieces. Also the plastic need to be resident to different weather conditions. Such as sunlight, rain and storm. For this there are two kinds of thickness for the plastic. Plastic with the thickness 150 µm and 200 µm.
The last quality requirement is that the plastic last for more than one year. This because a farmer doesn't use all his silage in one year, so the residues also need to be covered.

The plastic for wrapping up the grass has the same requirements as the plastic used to cover up the

silage. The big difference of the plastic is that it is thinner and the use more layers for the covering.

According to Jan van Zuijlen there are no requirements from the government regarding the agricultural plastic.

How much quantities of plastic do you sell to the farmer in the region of Alblasserwaard And Vijfheerenlanden?
According to Jan van Zuijlen Deltafeed buys 300 rolls of agricultural plastic per years for the dairy farmers in the region Alblasserwaard and Vijfheerenlanden. Only the farmers which cooperate with Deltafeed use these rolls. So in the whole region and all the farmers together will use more than 300 rolls. Deltafeed buy it's roll from companies like Agrifirm, and Rijnvallei.

The price for the rolls are different, because there are different rolls. According to Jan van Zuijlen following dimensions are the most used in the region Alblasserwaard & Vijfheerenlanden.

Width: 12 meters
Length: 50 meters
Thickness: 0.15mm (150 µm)
Colour : Black
Price : €136 exclusive of VAT €164.56

The price per square meter is : €0.23 (12 x 50 = 600m2) (600m2 / €136 = €4.41)

Other many used rolls are :

Width: 14 meters
Length: 50 meters
Thickness: 0.15mm (150 µm)
Colour : Black
Price : €159 exclusive of VAT €192,39

The price per square meter is : €0.23 (14 x 50 = 700m2) (700m2 / €159 = €4.40)

What is the lifecycle of the agricultural plastic?
The agricultural plastic that the dairy farmers use can last for more than one year. So they use it till the quality requirements are no longer there. After the use the farmers need to bring the plastic to a local pick-up point. On this point are different containers to separate the plastic. Because the plastic for wrapping the grass is different than the plastic for covering the silage.
When the containers are full the company Daily plastics will pick-up the containers full of plastic and depots it. Jan van Zuijlen thinks this plastic is used for recycling but he could not confirm this. He doesn't know what happens to the plastic.

Have you ever considered to use biodegradable plastic instead of oil based plastic?
Jan van Zuijlen don't know how the plastic is made, because he only buys the plastic. Also Jan van Zuijlen never considered to use biodegradable plastic. The reason for this is, that he didn't know that there is biodegradable plastic.

Requirements for the biodegradable plastic are the same as for the oil based plastic. Plus the biodegradable plastic shouldn't breakdown within one year, because the plastic is used for at least one year. Otherwise the plastic wouldn't be useful to use.