Cost Benefit Analysis of Mussel Processing

Zaiga Ozolina

Kurzeme planning region

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FLAGSHIP

About

Baltic Blue Growth is a three-year project financed by the European Regional Development Fund. The objective of the project is to remove nutrients from the Baltic Sea by farming and harvesting blue mussels. The farmed mussels will be used for the production of mussel meal, to be used in the feed industry. 18 partners from 7 countries are participating, with representatives from regional and national authorities, research institutions and private companies. The project is coordinated by Region Östergötland (Sweden) and has a total budget of 4,7 M€.

Partners

- *Region Östergötland (SE)*
- *County Administrative Board of Kalmar County (SE)*
- *East regional Aquaculture Centre VCO (SE)*
- *Kalmar municipality (SE)*
- *Kurzeme Planning Region (LV)*
- *Latvian Institute of Aquatic Ecology (LV)*
- *Maritime Institute in Gdańsk (PL)*
- *Ministry of Energy, Agriculture, Environment, Nature and Digitalization of Schleswig-Holstein (DE)*
- *Municipality of Borgholm (DK)*
- *SUBMARINER Network for Blue Growth EEIG (DE)*
- *Swedish University of Agricultural Sciences (SE)*
- *County Administrative Board of Östergötland (SE)*
- *University of Tartu Tartu (EE)*
- *Coastal Research and Management (DE)*
- *Orbicon Ltd. (DK)*
- *Musholm Inc (DK)*
- *Coastal Union Germany EUCC (DE)*
- *RISE Research institutes of Sweden (SE)*

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Executive summary

The cost benefit analysis of processed Blue mussel is prepared based on the information gathered for the Baltic Blue Growth project.

Cost summary figures indicate the possible benefits for obtaining insect larvae meal and its advantages, as well as the harvesting and processing of Blue mussel in the Baltic Sea, which can be used as fertilizer as well as animal feed additive.

The document uses a cost-benefit analysis of two types - processing and output, using the net present value and the internal rate of return of the project, as well as combining it with different scenarios that might leave an impact on the value of the processed product.

The demand in the poultry industry has increased significantly. In this study, the effect of using mussel meal was measured in two ways - as feed or as obtaining of insect meal, which might be used to feed fish.

Although Blue mussel, grown in the Baltic Sea region, is smaller, it can still be processed for animal feed. In this project other uses of the above mentioned invertebrates were not studied in detail.

Blue mussel, as animal feed, can partly replace imported products, thus increasing tax payments into the State and municipal budgets, and would foster the employment in the region.

The use of Blue mussel, harvested and processed in the Baltic Sea region, is likely to be crucial to reduce transport CO_2 emissions as well.

It should be noted that the processing of Blue mussel in animal feed requires considerable investments, therefore the information obtained in the project did not give a clear answer about their benefits.

According to experts and scientists, the harvesting period of Blue mussel does not take place throughout the year, therefore it is advisable to integrate the processing process with processing taking place in other business sectors, so as to provide employees with full employment and streamline the operational capacity of the plant.

Cost benefit analysis of mussel processing				
Description	***Raw material (blue mussel) purchase price EUR/ton***	***Investment amount, TEUR***	***NPV, TEUR, discount rate 4,4%***	*IRR, %*
Mussel as feed				
Mussel as feed, investment on 10 years	500	5 000	-31000	-
Scenario				
Raw material (blue mussel) purchase price is 80 EUR/ton	80	5 000	-300	-2,9%
Raw material (blue mussel) purchase price is 80 EUR/ton; Harvest losses are estimated at 10% instead of the previous 5%.	80	5 000	-933	-6,2%
Raw material (blue mussel) purchase price is 80 EUR/ton; The project is implemented by attracting the EU Structural Funds, external co-financing amounts to 40%.	80	5 000	1535	6,2%

Cost benefit analysis of mussel processing				
Description	***Raw material (blue mussel) purchase price EUR/ton***	***Investment amount, TEUR***	***NPV, TEUR, discount rate 4,4%***	*IRR, %*
Investment amount – EUR 2 million, raw material (blue mussel) purchase price is 80 EUR/ton; The project is implemented through the involvement of the EU Structural Funds, external co-financing amounts to 40%.	80	2 000	1158	14,1%
Insect meal				
Insect meal, 5 years	50	45	1,7	6,6%
Scenario				
investment period - 10 years	50	71	18	15,7%
Receiving financial support to cover 50% of investment, investment on 5 years	50	45	22	40,2%
Receiving financial support to cover 50% of investment, investment on 10 years	50	71	38	41,4%

Scenario analysis revealed, that the profit, based on the existing selling prices of processed Blue mussel, can be achieved if the acquisition price of Blue mussel is low, when there are investments of approximately EUR 2 million (10000 tons per year).

The cost of setting up an insect larvae meal processing site is significantly lower, but the processing costs are calculated for 1 trial case.

During the insect larvae meal process, the yield of processed Blue mussel gave a better result for the internal rate of project return, which was positive, if the investment period was set for the period of 10 years.

Within the framework of the project the processed Blue mussel used in feed were studied.

However, the study field of animal feed is complex – there are many components composing animal feed, therefore further research would help to explore the possible use of Blue mussel as a feed and its respective cost benefits.

In general, the cost of processed Blue mussel would contribute to both the environment and society in general. However, in order to better assess the benefits of such a complex process, it is necessary to carry out additional studies.

Introduction

The European compound feed industry employs over 110000 persons at approximately 4000 production sites, mostly in rural areas, offering additional employment opportunities. It is estimated that in the EU 28 the consumption of animal feed in farms constitute 478 million tonnes per year, whereof about 30% (156 million tonnes) are produced by compound feed manufacturers. The estimated turnover of the European compound feed industry was €55 billion in 2015 (FEFAC.eu).

Feed additives are substances, micro-organisms or sub-products that are intentionally added to feed or water in order to perform one or more of the functions described in the Article 5 of Regulation (EC) No 1831/2003, on additives for use in animal nutrition. All feed additives placed on the market in the European Union must be approved under the auspices of the Regulation (EC) No 1831/2003 (The EU).

The major cost factor for the livestock farmers is the feed, e.g. constituting up to 85 % of the production cost for poultry. It is estimated that in the EU 27 the consumption of animal feed in farms constitute 467 million tonnes per year, whereof 150 million tons are produced by the compound feed manufacturers (the worldwide compound feed production amounts up to 700 million tons). The breakdown of 150 million tons of compound feed production in the EU-27 was in 2008, where pig feed was 35%, feed for broilers and laying hens - 33%, cattle feed - 25%. The rest percentage of total amount of feed was 1% for milk replacers and 7% for other livestock. The European feed industry is increasing the volume of by-products from the food and biofuel industry. An average compound feed formula constitutes 40 % of these by-products (by-product in biofuel industry not specifically mentioned). Moreover, livestock farmers use approximately 228 million tons of forage and 89 million tons of feed substance (home-grown cereals or purchased feed materials).[1]

Animal feeding plays the leading role in the global food industry and feed is the largest and most important component to ensure the sustainable production of safe and affordable animal proteins (FAO, 2015). The feed, according to the International Feed Industry Federation (hereinafter – IFIF), production reached 1 billion tonnes in 2015. Total volume of produced feed estimated 375 billion EUR (IFIF, 2015).

Feed industry market is developed due to increasing demand of high-quality product. Safe feed products enable farms to ensure food safety, reduce production costs, maintain or increase food quality and consistency and enhance animal health and welfare by providing adequate nutrition at every stage of growth and production. They can also reduce possible pollution from animal wastes by providing the necessary amounts of highly bio-available dietary nutrients (FAO, 2010).

In 2015 feed market increased by 2% comparing to previous year.

According the IFIF publication, the main market players are acting in China 19%, USA 17%, Europe 16%, and 48% of rest of the world. This information shows that Europe is playing an important role in the whole market.

[1] http://www.eufetec.eu/FeedIndustry.aspx

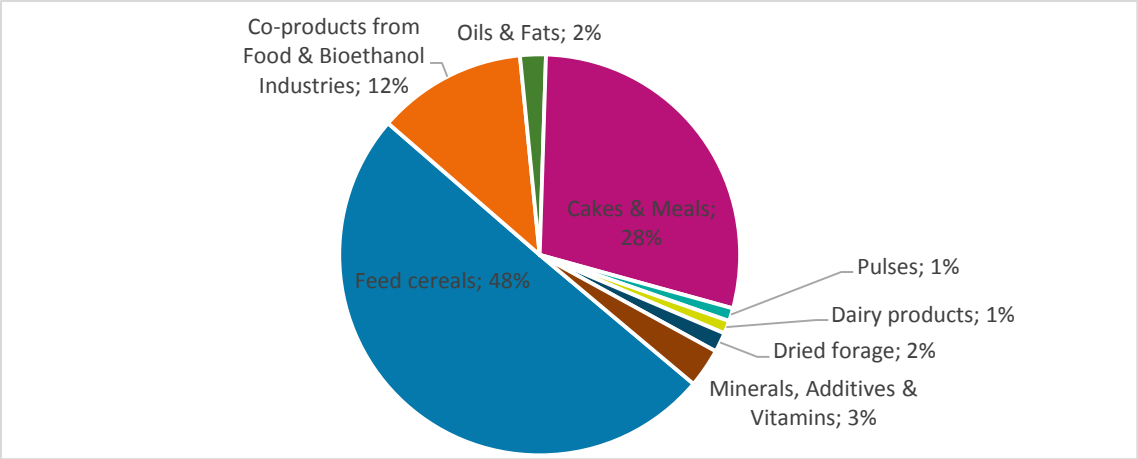

Figure 1 Use of feed materials by the EU-28 feed industry in 2014 (FEFAC, 2016)

The main substance of feed is cereals 48% of all feed materials.

The expected growth of the global poultry feed market by 2020 shall reach to $220 billion in comparison with $182.5 Billion in 2013 (Business Wire, 2016).

FAO estimates that production volumes would have to increase by 70% to be able to feed the world in 2050, with meat outputs (poultry, pork and beef) expected to double (IFIF, 2012). Insects have a similar market to fishmeal; they are employed as feed in aquaculture and livestock and also used in the pet industry. Recent high demand and consequent high prices for fishmeal, together with increasing production pressure on aquaculture, has led to research for new source - the development of insect proteins for aquaculture and livestock (which could eventually supplement fish meal). Meanwhile, aquaculture is growing and, as a source of feed, fishmeal is declining rapidly, because of decreased supplies of industrially caught fish due to tighter quotas, additional controls on unregulated fishing, and greater use of more cost-effective dietary fishmeal substitutes (van Huis et.al, 2013).

Blue mussel farming is a new field in the Baltic Sea region and it might fill the gap due to reducing fish livestock. Blue mussel contains a numerous high value nutrient, and it might increase the product value. Mussel farming like fishery might provide only primary processing. Nevertheless, to increase product value and number of and dissemination of possible outlets, it might include further processing. Another aspect is to increase the storability by further processing because of a short realisation period after the harvesting. Thus, different processing options as well as end-products have been discussed in the Baltic Blue Growth project, offering two kinds of possible products of the Baltic Sea mussel:

- Mussel meal is produced from the meat of blue mussels, that can be used in poultry feed
- Insect larvae that are dried or milled, where the larvae would be produced by using fresh blue mussels as their feed.

Both options have the background in replacing fishmeal in feed with a mussel-based product, that would have the same nutritious- and digestible values as fishmeal that is used at the moment.

Dried mussel meal was used to feed poultry in Sweden in trial. The biological aspect has been described in the report by Kristin Bertilius.

The production of insect larvae meal, reared on blue mussels from the Baltic Sea, is described in the project report “Processing and storage of mussels: mussels to feed through fly larvae” by Ola Palm, Cecilia Lalander and Aleksandar Vidakovic.

In all cases the processing has been performed in experimental conditions or based on expert judgements.

The goal of this paper is to conduct the mussel meal processing cost benefit analysis based on information obtained in this project. The paper is developed for stakeholders and outlines the outcome of this project.

Methodology

The goal of the study was to measure the effectiveness of processing mussel meal and analyse alternative actions and perform scenario analysis, to predict outcomes of the cost and benefit gained in a certain period of time.

To assess benefits using mussel meal the information was obtained as follows:

1. Expert interviews:
    - Fertilizer producing site using blue mussel as one of the raw materials
    - Processing site of blue mussel
    - Poultry factory – using mussel as one of the feed components
    - Food factory – using mussel
    - Engineering company establishing feed processing sites
2. Quantitate analysis - industry analysis
    - To analyse and obtain product price, industry development potential etc.
3. Collecting information from processing sites
4. Applying cost benefit analysis
    - Time schedule of project activities
    - Cash flow from investing activities
    - Cash flow from financing activities
    - Cash flow from operating activities
        - Revenue plan
        - Profit loss statement, profitability indicators
    - Cash flow forecast
    - Applying discounted cash flow method

The discounted cash flow method is applied to estimate how valuable the investment is worth by estimating its future returns adjusted for the time value of money (Rama – Poccia, 2018).

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n}$$

- Calculating discount rate

Discount rate indicated the cost of borrowing money (Gallo et al., 2017).

Er = Rf + β(Rm - Rf)

Beta (*β*)—this is a measure of systematic risk of a stock relative to the market (i.e., the covariance between the stock and the stock market as a whole)

Expected market return (*Rm*)—this can be the average return of a selected index or an "accepted return" based on consensus estimates

Risks	Risk rate	Source of information
Risk-free interest rate (Rf)	0.40	10-year government bond rate in Sweden
Equity risk (*Rm)*	5.96	Damodaran data base
Beta industry (***β***)	0.72	Damodaran data base
TOTAL	**4.40**	

Discount rate was calculated 4.4 %.

- Calculation of net present value

Net present value (NPV) the present value of the cash flows at the required rate of return of your project compared to your initial investment.

J.Knight has described NPV in the following ”any investment that passes the net present value test will increase shareholder value and any investment that fails would (if carried out anyway) actually hurt the company and its shareholders” (Gallo et.al 2017).

$$\mathrm{NPV} = \sum_{\mathrm{n}=0}^{\mathrm{N}} \left(\frac{\mathrm{R}^{\mathrm{t}}}{(1+\mathrm{i})^{\mathrm{n}}}\right)$$

N-holding period

n-each period

- Calculation of financial profitability

Internal rate of return (IRR) is the interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment equal zero (Investinganswer).

$$0 = NPV = \sum \frac{CF_n}{(1+IRR)^n}$$

CF- cash flows

IRR – internal rate of return

- Scenario analysis

Cost benefit analysis was done for two types of products

- Mussel meal is produced from the meat of blue mussels, which can be used in poultry feed
- Insect larvae that are dried or milled, where the larvae is produced by using fresh blue mussels as their feed.

The benefits of the study were looked at using local blue mussel and the possible reimbursement for the production process.

Production and processing results using blue mussel

To prepare cost benefit analysis it is important to find out cost and volumes of raw material and processed product.

Blue mussel processing has been done in several countries (e.g. Norway, Sweden, China). Results indicate the following outcomes – by processing 100% of blue mussel (frozen of fresh) it is possible to obtain:

- 3-5% of mussel powder
- 35-50% of mussel shell
- Rest amount is water and waste

The results differ due to mussel size, composition of mussel during harvesting, conditions for transportation, humidity ratio in processed product etc.

Obtained mussel meat powder contains high concentration of different ingredients (phosphorus, nitrogen, Omega 3 etc.) thus making mussel meal as a high valuable product for animal feed or as a fertilizer etc.

Cost benefit analysis using mussel as feed

Mussels are high-quality poultry feed ingredient, since they contain not only the necessary proteins, but also their shell contains easily digestible calcium. In this case, the cost for making shellfish flour as a poultry feed additive is reduced because it is not necessary to separate the shell from the blue mussel.

The use of shellfish and their processed products to improve soil - the production of humus – theoretically can be profitable. However, shellfish flour should be considered as a high-quality source of animal protein, and such type of product use may be the last resort to be used, for example, if the product has already become defective or does not meet veterinary requirements.

The regulatory framework for the use of blue mussel for soil improvement varies from country to country.

Time schedule of project activities

Table 1 Time schedule of project activities

Activities	1st year (start of the project)				2nd year and subsequent years			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Starting the project		X						
Investment in production: fixed assets and equipment			X	X				
Production / cultivation of mussels					X	X	X	
Recruitment of staff: Production Manager		X						
Recruitment of staff: production personnel					X			
Harvesting (every year from April to October except July and August)						X	X	X
Sales activities					X	X	X	X

1st year of operation – year of implementation of the project.

2nd year of operation – industrial production, production and marketing of molluscs are started.

Project implementation time is 10 years. This is the period when the attracted funding and the loan interest are paid.

Cash flow from investing activities

Project investments are planned in the first year of operation at EUR 5 million.

Such investment amount is planned by representatives of meal processing companies. The investment covers obtaining equipment – dryers, graders, sieve etc., and it does not cover construction cost in meal processing site.

Fixed assets are depreciated over 10 years. Starting from the 2nd year, EUR 500 thousand are planned for depreciation.

Cash flow from financing activities

Cash flow from financing activities includes cover of investment cost EUR 5 million, and 22% of investment as own financing in the 1st year.

Total long-term loan: EUR 5 million received in the first year of operation. A 3% loan rate is applied. The loan is paid in 10 years. Fixed payment of the received loan - starting from the second year of operation.

Cash flow from operating activities

Production costs

Each year EUR 4000 is planned for laboratory tests and analyses, according to the experts suggestions.

Given that the average cost of production of shellfish farming ranges from 0.1 to 0.5 EUR/kg, the project estimates that production costs for the project would be of the highest 0.5 EUR/kg. It is planned to harvest 10000 tonnes of molluscs every year, and production losses - up to 10%. In the project, losses are calculated at 5% of the production volume. The production volumes are constant every year.

The cost of electricity for the project in the 1st is EUR 20 000, starting with the 2nd - EUR 49 500 (which are calculated as: 2000 hours of work each year x 75 kWh x 3 processing equipment x 0,11 EUR / kWh). In the coming years, every 3rd year the increase in the price is expected due to rising of 5-10% percent of electricity tariffs.

The cost for packaging and logistics have been calculated based on expert interviews, and its estimation EUR 160000 every year.

Administration costs

The administration costs in each Baltic Sea region vary depending on the veterinary requirements as well as the charges imposed by countries concerned and local authorities (see other costs).

According to the financial data from existing processing companies in the Baltic Sea Region, administrative costs in average are 5% of production costs.

Sales costs are calculated at 1% of net turnover.

Staff remuneration (direct costs)

It is planned to employ a Production Manager in the year of the beginning of the project, but with the start of the second year of operation, when the cultivation, harvesting and marketing will be started, five production workers will be recruited. The total workload from April to October will be 640 h per month.

The average hourly rate is 24.8 EUR / h, including all employee and employer taxes. The total cost of personnel is EUR 158.7 per year (starting with the 2nd year).

Cost of staff

	Y1			Y2 and further		
	Hours	Rate per hour (EUR/h)	**Salary, EUR**	**Hours**	Rate per hour (EUR/h)	**Salary, EUR**
Jan		24,8	0	**160**	24,8	3968
Feb		24,8	0	**160**	24,8	3968
Mar		24,8	0	**160**	24,8	3968
Apr		24,8	0	**800**	24,8	19840
Mai	**160**	24,8	3968	**800**	24,8	19840
Jun	**160**	24,8	3968	**800**	24,8	19840
Jul	**160**	24,8	3968	**800**	24,8	19840
Aug	**160**	24,8	3968	**800**	24,8	19840
Sep	**160**	24,8	3968	**800**	24,8	19840
Oct	**160**	24,8	3968	**800**	24,8	19840
Nov	**160**	24,8	3968	**160**	24,8	3968
Dec	**160**	24,8	3968	**160**	24,8	3968
Total	**1280**		**31744**	**6400**		**158720**

Revenue plan

Revenue plan was established based on the results from 2 processing sites (fertilizer processing and meal processing site).

The results revealed that, by applying mussel cold of dry processing it is have three products - mussel powder, mussel meal with mussel shells and shells. The suggested time for the harvesting of molluscs is April/May to September/October (depends on weather conditions in spring and autumn). In summer period the amount of nutrients in the water increases, so environmental experts do not recommend harvesting in the period of July and August.

Within the project, a significant emphasis was put on the weight of molluscs used and recycled, which showed that water constitutes 40-50% of the total weight. Depending on the technology used, the composition and weight of the processed shellfish changes.

During the project, the annual volume of harvested and processed mussel is estimated to be constant at 4750 t per year, divided into three product types: Shell, Mussel meal with mussel shells (Mix) and Mussel powder. The chart below demonstrates the product division types and their percentage.

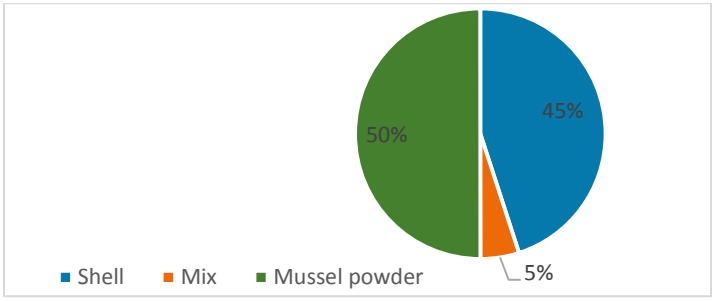

Figure 2 Product types share in revenue

Mussel meal processing

Taking into consideration that installation of equipment might take up to 9-12 months, the revenue plan is estimated starting from the second year.

Table 2 Revenue plan of shell, mussel meal and mussel shell product (mix) and mussel flesh

Shell (45%)	Month	Amount (t)	Realised amount (t) (90 days)	Price (EUR/t)	Revenue (EUR)
	Jan			80	0
	Feb			80	0
	Mar			80	0
	Apr	**475**	0	80	0
	Mai	**475**	0	80	0
	Jun	**475**	0	80	0
	Jul		475	80	38000
	Aug		475	80	38000
	Sep	**713**	475	80	38000
	Oct		0	80	0
	Nov		0	80	0
	Dec		713	80	57000
	"Shell" total	**2138**	**2138**	**80**	**171000**

Mix (50%)	Month	Amount (t)	Realised amount (t) (90 days)	Price (EUR/t)	Revenue (EUR)
	Jan			380	0
	Feb			380	0
	Mar			380	0
	Apr	**475**	0	380	0
	Mai	**475**	0	380	0
	Jun	**475**	0	380	0
	Jul		475	380	180500
	Aug		475	380	180500
	Sep	**950**	475	380	180500
	Oct		0	380	0
	Nov		0	380	0
	Dec		950	380	361000
	"Mix" total	**2375**	**2375**	**380**	**902500**

	Month	Amount (t)	Realised amount (t) (90 days)	Price (EUR/t)	Revenue (EUR)
Mussel flesh (5%)	**Jan**			2800	0
	Feb			2800	0
	Mar			2800	0
	Apr	**48**	0	2800	0
	Mai	**48**	0	2800	0
	Jun	**48**	0	2800	0
	Jul		48	2800	133000
	Aug		48	2800	133000
	Sep	**95**	48	2800	133000
	Oct		0	2800	0
	Nov		0	2800	0
	Dec		95	2800	266000
	"Mussel powder" total	**238**	**238**	**2800**	**665000**
	TOTAL	**4750**			**1738500**

Total annual revenue from production is EUR 1.7 million. The price per tonne of each product is determined by the market price.

Profit and loss statement, profitability indicators

Table 3 Profit and loss statement of processed mussel in EUR, profitability ratio

	Y1	Y2	Y3	Y4	Y5		Y10
Revenue	**0**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**		**1 738 500**
Production cost	55 744	5 372 220	5 378 220	5 380 695	5 380 695		5 383 170
Admin.& Sales costs	2 787	285 996	286 296	286 420	286 420		286 544
EBITDA	**-58 531**	**-3 919 716**	**-3 926 016**	**-3 928 615**	**-3 928 615**		**-3 931 214**
Depreciation	0	500 000	500 000	500 000	500 000		500 000
Interest cost	75 000	138 750	116 250	93 750	71 250		0
EU support	0	0	0	0	0		0
Income tax, 22%		0	0	0	0		0
Net profit	**-133 531**	**-4 558 466**	**-4 542 266**	**-4 522 365**	**-4 499 865**		**-4 431 214**

Blue mussel as raw material purchase price is 500 EUR/ton.

EBITDA profitability ratio	**-226%**	**-226%**	**-226%**	**28%**
Net profitability ratio	**-261,3%**	**-260,1%**	**-258,8%**	**22,0%**

Detailed profit and loss statement for 10 years is available in Annex No. 1.

The project implementer is not able to cover the production costs of such economic activities. In the 2nd year of operation, when the production process and sales have started, the company net profit is negative.

Tax payments is calculated 66000 EUR per year by involving 5 persons (part time employment).

The project cash flow is divided into 3 parts: cash flow from operating activities, cash flow from investment activities, and cash flow from financing. The working capital cycle is 90 days.

Cash flow forecast

Table 4 Cash flow forecast, EUR

	Y1	Y2	Y3	…	Y9	Y10
CF in the beginning of period	**0**	**866 469**	**-3 941 997**		**-32 130 034**	**-35 561 248**
CF from operating activities	**-133 531**	**-4 058 466**	**-4 042 266**		**-3 431 214**	**-3 931 214**
CF from investment activities	**-5 000 000**	**0**	**0**		**0**	**0**
CF from financing activities	**6 000 000**	**-750 000**	**-750 000**		**0**	**0**
CF at the end of period	**866 469**	**-4 808 466**	**-4 792 266**		**-3 431 214**	**-3 931 214**

The NPV (applying 4.4% discount rate) of the project is negative EUR-31 million and IRR is negative.

Negative IRR revealed that the project brings less benefit than investment in other projects.

Detailed cash flow for 10 years is available in Annex No.1.

Scenario analysis

Sensitivity analysis was conducted for following scenarios:

1) Raw material (blue mussel) purchase price is 80 EUR/ton

2) Raw material (blue mussel) purchase price is 80 EUR/ton; Harvest losses are estimated at 10% instead of the previous 5%.
3) Raw material (blue mussel) purchase price is 80 EUR/ton; The project is implemented by attracting the EU Structural Funds, external co-financing amounts to 40%.
4) Investment amount – EUR 2 million, raw material (blue mussel) purchase price is 80 EUR/ton; The project is implemented through the involvement of the EU Structural Funds, external co-financing amounts to 40%.

1. The purchase price of raw material purchase price is 80 EUR/kg (the lowest level)

The lowest production cost of the blue mussel harvested in the Baltic Sea region varies from 0.5 to 0.54 EUR/kg (Ozolina, 2018).

In the course of the Baltic Blue Growth project it was stated that mussel farming sales could be analysed within the nutrient removal goal, receiving 0.24 EUR/kg of the harvested blue mussel from removal of nitrogen and 0.18 EUR/kg of the harvested blue mussel from removal of phosphorus (Minnhagen *et.al.* 2018/2019). The purchase price of raw material is estimated 80 EUR/kg.

Profit and loss statement

Table 5 Profit and loss statement of processed mussel in EUR, profitability ratio

	Y1	Y2	Y3	Y4	Y5		Y10
Revenue	**0**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**		**1 738 500**
Production cost	55 744	1 172 220	1 178 220	1 180 695	1 180 695		1 183 170
Admin.& Sales costs	2 787	75 996	76 296	76 420	76 420		76 544
EBITDA	**-58 531**	**490 284**	**483 984**	**481 385**	**481 385**		**478 787**
Depreciation	0	500 000	500 000	500 000	500 000		500 000
Interest cost	75 000	138 750	116 250	93 750	71 250		0
EU support	0	0	0	0	0		0
Income tax, 22%		0	0	0	0		0
Net profit	**-133 531**	**-148 466**	**-132 266**	**-112 365**	**-89 865**		**-21 214**

Detailed profit and loss statement for a period of 10 years is provided in Annex 2.

EBITDA profitability ratio	**28%**	**28%**	**28%**	**28%**
Net profitability ratio	**-7,6%**	**-6,5%**	**-5,2%**	**-1,2%**

Net profit is negative in each period and therefore the net profitability ratio is negative. Previous analysis of similar processing companies' financial ratio has indicated EBITDA profitability ratio is 10-30% and net profitability ratio is 2-10%.

Considering that the project analysis includes costs related to the achievement of project tasks, project EBITDA ratio should be higher.

Cash flow forecast, calculating IRR and NPV

Table 6 Cash flow, EUR

	Y1	Y2	Y3	...	Y9	Y10
CF in the beginning of period	**0**	**866 469**	**468 003**		**-1 260 034**	**-781 248**
CF from operating activities	**-133 531**	**351 534**	**367 734**		**478 787**	**478 787**

CF from investment activities	-5 000 000	0	0		0	0
CF from financing activities	6 000 000	-750 000	-750 000		0	0
CF at the end of period	866 469	-398 466	-382 266		478 787	478 787

The NPV (applying a 4.4% discount rate) of the project is negative EUR 300 thousand and the IRR is negative (-2.9%).

2. Raw material (blue mussel) purchase price is 80 EUR/tonne. Loss of raw materials is estimated to be 10 % instead of the previous 5 %.

A certain part of raw material is lost during the product processing. In this scenario it was estimated to be 10 %, whereas the price of purchase for raw material is **80 EUR/tonne.**

Profit and loss statement

Table 7 Profit and loss statement of processed mussel in EUR, profitability ratio

	Y1	Y2	Y3	Y4	Y5		Y10
Revenue	**0**	**1 647 000**	**1 647 000**	**1 647 000**	**1 647 000**		**1 647 000**
Production cost	55 744	1 172 220	1 178 220	1 180 695	1 180 695		1 183 170
Admin.& sales costs	2 787	75 081	75 381	75 505	75 505		75 629
EBITDA	**-58 531**	**399 699**	**393 399**	**390 800**	**390 800**		**388 202**
Depreciation	0	500 000	500 000	500 000	500 000		500 000
Interest cost	75 000	138 750	116 250	93 750	71 250		0
EU support	0	0	0	0	0		0
Income tax, 22%		0	0	0	0		0
Net profit	**-133 531**	**-239 051**	**-222 851**	**-202 950**	**-180 450**		**-111 799**

Net profit is negative in each period, however losses might be covered by ½ of depreciation.

EBITDA profitability ratio	**25%**	**25%**	**25%**	**24%**
Net profitability ratio	**-12,3%**	**-11,1%**	**-9,8%**	**-5,6%**

Cash flow forecast and analysis of benefit

Table 8 Cash flow, EUR

	Y1	Y2	Y3	...	Y9	Y10
CF in the beginning of period	0	866 469	377 418		-1 894 129	-1 505 928
CF from operating activities	-133 531	260 949	277 149		388 202	388 202
CF from investment activities	-5 000 000	0	0		0	0
CF from financing activities	6 000 000	-750 000	-750 000		0	0
CF at the end of period	866 469	-489 051	-472 851		388 202	388 202

Detailed profit and loss statement and cash flow per years is available in Annex No. 3.

The NPV (applying a 4.4% discount rate) of the project is negative EUR-933 thousand and the IRR is negative (-6.2%).

3. The purchase price for raw material (blue mussel) is 80 EUR/tonne. The project is implemented by the attraction of the EU Structural Funds, external co-financing amounts to 40 %.

The purchase price of raw material is estimated 80 EUR/kg. The project is implemented by the attraction of the EU Structural Funds, external co-financing amounts to 40 %.

Profit and loss statement

Table 9 Profit and loss statement of processed mussel in EUR, profitability ratio

	Y1	Y2	Y3	Y4	Y5		Y10
Revenue	**0**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**		**1 738 500**
Production cost	55 744	1 172 220	1 178 220	1 180 695	1 180 695		1 183 170
Admin.& Sales costs	2 787	75 996	76 296	76 420	76 420		76 544
EBITDA	**-58 531**	**490 284**	**483 984**	**481 385**	**481 385**		**478 787**
Depreciation	0	500 000	500 000	500 000	500 000		500 000
Interest cost	75 000	138 750	116 250	93 750	71 250		0
EU support	0	250 000	250 000	250 000	250 000		0
Income tax, 22%		0	0	0	0		0
Net profit	**-133 531**	**101 534**	**117 734**	**137 635**	**160 135**		**-21 214**

EBITDA profitability ratio	**28%**	**28%**	**28%**	**28%**
Net profitability ratio	**6,8%**	**7,9%**	**9,2%**	**-1,2%**

Net profitability ratio is 13.5% in Y10.

Cash flow forecast and analysis of benefit

Table 10 Cash flow, EUR

	Y1	Y2	Y3	...	Y9	Y10
CF in the beginning of period	**0**	**866 469**	**2 468 003**		**739 966**	**1 218 752**
CF from operating activities	**-133 531**	**351 534**	**367 734**		**478 787**	**478 787**
CF from investment activities	**-5 000 000**	**0**	**0**		**0**	**0**
CF from financing activities	**6 000 000**	**1 250 000**	**-750 000**		**0**	**0**
CF at the end of period	**866 469**	**1 601 534**	**-382 266**		**478 787**	**478 787**

Detailed profit and loss statement and cash flow per years is provided in Annex 4.

The NPV (applying a 4.4% discount rate) of the project NPV is EUR 1.5 million and the IRR is 6.2%.

4. **Total investment amounts to 2 million euros, purchase price for raw material (blue mussel) is 80 EUR/tonne. The project is implemented by the attraction of the EU Structural Funds, external co-financing amounts to 40 %.**

Total investment is determined in the amount of 2 million euros in this case analysis. In expert interviews it was revealed that 4 million euros were not enough to obtain equipment for one factory. However, less than 2 million euros were invested in a processing company in China to establish mussel meal processing line and their production volume is higher than 10000 tonnes per year and more workforce is needed.

Profit and loss statement

Table 11 Profit and loss statement of processed mussel in EUR, profitability ratio

	Y1	Y2	Y3	Y4	Y5		Y10
Revenue	**0**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**		**1 738 500**

Production cost	55 744	1 330 940	1 336 940	1 339 415	1 339 415		1 341 890
Admin.& Sales costs	2 787	83 932	84 232	84 356	84 356		84 480
EBITDA	**-58 531**	**323 628**	**317 328**	**314 729**	**314 729**		**312 131**
Depreciation	0	200 000	200 000	200 000	200 000		200 000
Interest cost	30 000	55 500	46 500	37 500	28 500		0
EU support	0	100 000	100 000	100 000	100 000		0
Income tax, 22%		36 988	37 582	38 990	40 970		24 669
Net profit	**-88 531**	**131 140**	**133 246**	**138 239**	**145 259**		**87 462**

Production cost has increased due to doubling cost of labour workforce.

EBITDA profitability ratio	**18%**	**18%**	**18%**	**18%**
Net profitability ratio	**7,7%**	**8,0%**	**8,4%**	**5,0%**

Net profit ratio is 6% in Y10.

Cash flow forecast and analysis of benefit

Table 12 Cash flow, EUR

	Y1	Y2	Y3	...	Y9	Y10
CF in the beginning of period	**0**	**311 469**	**1 042 609**		**832 025**	**1 097 486**
CF from operating activities	**-88 531**	**231 140**	**233 246**		**265 462**	**287 462**
CF from investment activities	**-2 000 000**	**0**	**0**		**0**	**0**
CF from financing activities	**2 400 000**	**500 000**	**-300 000**		**0**	**0**
CF at the end of period	**311 469**	**731 140**	**-66 754**		**265 462**	**287 462**

Detailed profit and loss statement and cash flow per years is provided in Annex 5.

The NPV (applying a 4.4% discount rate) of the project NPV is 1.2 million euros and the IRR is 14,1%.

This scenario provides the highest IRR rate and requires the lowest investment cost.

High value raw product should increase produced product value.

Cooperation between mussel farmer and processing sites or even joint collaboration will increase product value and provide market with high value product.

Insect meal CBA analysis

As there is increase in world population, there is a growing shortage of animal protein. With the intensification of livestock farming and the subsequent concentration of animals, the outbreak of animal diseases and the disposal of their excrement are increasing. So far, fishmeal was the most used as a source of protein for farm animals. However, with the decrease in fish resources, fishmeal prices are rising dramatically. Consequently, we see, on the one hand, that prices of protein sources for animal growth are increasing worldwide, thus, increasing the price of end products - fish and poultry meat (FAO, 2013).

In this context, blue mussel can be used as both as an independent protein source for poultry as well as an insect larvae feed that later can be used as an ingredient in feed.

In order to solve the protein deficit in the diet of livestock, including aquaculture animals, proteins derived from insects are currently being introduced in the world. In this regard, it should be noted that insects are a natural source of nutrition for both poultry and fish. Consequently, the use of insects in poultry and fish feed does not affect the quality of their meat.

Cost position data was obtained in the project Baltic Blue Growth implementation process. A more detailed description of a suggested process line for mussels to feed through fly larvae can be found in the BBG-project report "*Processing and storage of mussels: mussels to feed through fly larvae*", written by Ola Palm, Cecilia Lalander and Aleksandar Vidakovic.

The calculations in this section are based on the process line flowchart in Figure 2, where the process line from Pre-process treatment (No 3.) to Post-process treatment (No 7.) is valid. It is assumed that the fly larvae composting is performed in racks that are placed in an insulated, heated and ventilated 40-feet sea container. Other processes, like crushing, separation and production of fish feed, are operated in a nearby building that is rented. In the calculation costs for investments, labour, electricity, water, wastewater treatment etc. are included.

In the calculations below the following assumptions have been made:

1. Yearly amount of mussels processed (fresh mussels with shells): 237 tons
2. Labour cost: 47,85 EUR/h

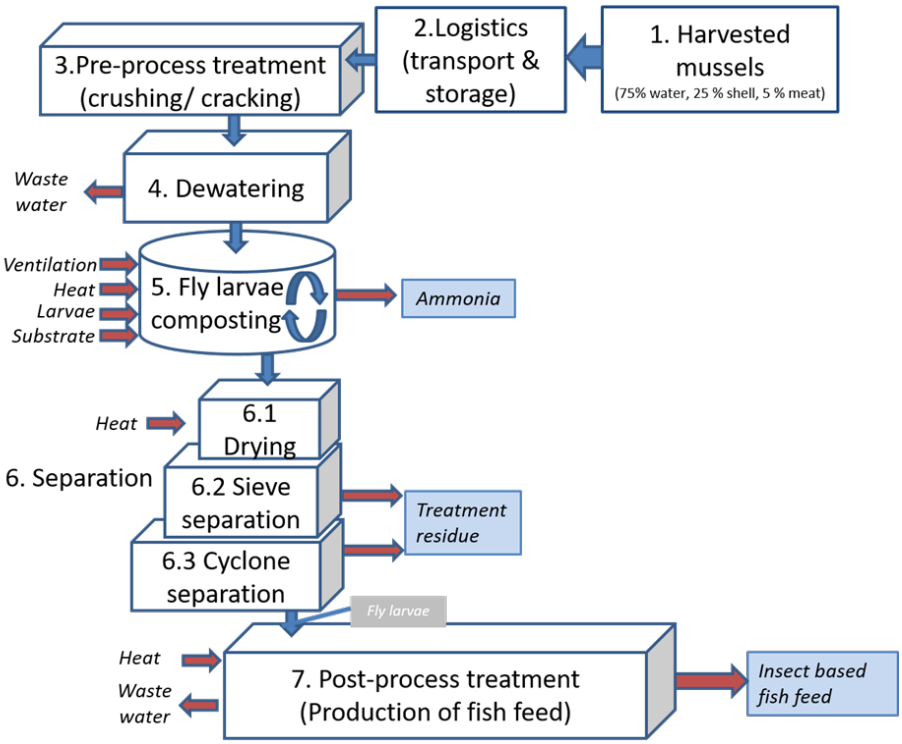

Figure 3 The process line flowchart

Cash flow from investing activities

Container preparation includes following cost position - insulation, studs, board coverage, fastener materials, metal floor, manhours for building, installation of floor heating system, installation of electricity, ventilation, and other costs.

Total container preparation cost is 19 TEUR.

Larvae production site – used container, heating pump, transportation of container till production site, connection of power, preparation of ground for container, connection of water and wastewater.

Larvae production site cost 11 TEUR.

Preparing for processing – used grinder, crushing equipment, separation equipment and small container, drying cabinet.

Investment cost in processing equipment – 15 TEUR.

Total investment cost 45 TEUR.

Depreciation period - 5 years.

After the 5th year it is necessary to obtain part of equipment for 26 TEUR.

Cash flow from operating activities

Production cost

Production cost is 44 TEUR.

	Cost per year, EUR
Raw material (mussel) (0.792 t/working day, 300 working days, 50 EUR/t)	11880
Formic acid 45 EUR/ton	10692
Rental cost (200 EUR/month)	2400
Electricity cost (10 MWh/year 200 EUR/MWh)	2000
Interest rate 3%	931
Labour cost	
Drying cabinet with plates, 25 EUR/ton of mussel	5685
Cleaning cost 25 EUR/ton of mussel	5685
Separation cost, 20 EUR/ton of mussel	4548
Total	**43820**

Calculating labour cost hours, it indicates that employee should work 3.5 hours per day.

Cash flow forecast

Table 13 Cash flow on 5 years

Cash flow	Y1	Y2	Y3	Y4	Y5
Obtained insect meal, tons	*6*	*6*	*6*	*6*	*6*
insect meal price EUR/tons	9000	9000	9000	9000	9000
Sales, EUR	54000	54000	54000	54000	54000
Production cost	43820	43820	43820	43820	43820
Investment cost	-45000				
Cash flow in the end of period	-34820	10180	10180	10180	10180

Financial cost is not included in this calculation.

Analysing insect meal price in market reveals that it is rather high, from 2 EUR up to 10 EUR per kg, therefore this product price is set high 9 EUR per kg.

Obtained dried insect meal price is set high because it contains many valuable things, including Omega-3.

Insect meal container is possible to establish within couple of months, therefore sales and production cost is included in the first year.

NPV obtaining insect meal is 1712 EUR (applying 4.4% discount rate), **and IRR is 6,6%** calculating for 5 years.

Calculated IRR rate is higher than calculated discount rate, and it indicates that investment repays.

Scenario analysis by receiving financial support to cover 50% of investment

Based on experts' suggestions, certain equipment (e.g. container) could serve for a longer period, therefore the calculation was revised for 10 years, where in the 6th year the second investment is envisaged.

10-year period calculation for insect meal provides a higher profitability.

Table 14 Cash flow on 10 years

	Y1	Y2	…	Y5	Y6	Y7	Y8	Y9	Y10
Tons	*6*	*6*		*6*	*6*	*6*	*6*	*6*	*6*
insect meal price EUR/tons	9000	9000		9000	9000	9000	9000	9000	9000
Revenue, EUR	54000	54000		54000	54000	54000	54000	54000	54000
Production cost	43820	43820	43820	43820	43820	43820	43820	43820	43820
Investment cost	-45000	22500				-26000			
Cash flow in the end of period	-34820	32680	10180	10180	10180	-15820	10180	10180	10180

NPV is 38 TEUR (discount rate 4,4) and IRR is 41%.

Production cost is high 82% in sales. It is possible to reduce production cost by half by achieving commercial size.

The equipment is placed in a container (standard 40' container has almost 30 m^2), therefore it does not require much space, the investment cost is 45 TEUR, which is lower than the investment costs using other technologies.

Scenario analysis - investment period - 10 years

It should be noted that it is possible to attract traditional financing e.g. bank loans, as well as alternative funding e.g. crowdfunding, for the development of a new product.

	Without support		Support 50% of investment	
	NPV	*IRR*	*NPV*	*IRR*
5 years	1 712 €	6,6%	22 356 €	40,2%
10 years	17 767 €	15,7%	38 410 €	41,4%

It is possible to attract the EU support of 50% from the total investment cost.

Applying the same calculation to get zero IRR (Scenario – investment period – 10 years, attracting EU support), the calculations show that sales price for the insect meal can be reduced to 8195 EUR per ton.

Insect larvae meal perspectives

Price for fish meal is above 1300 EUR/ton, according to FAO data in 2017. Price for fish meal has a tendency to increase by 30% in summer period (Marine Harvest, 2018). Mussel can partly cover the increasing market demand.

The blue mussel as a raw material contains nutrients which are possible to be uptaken from the sea water.

The addition of insect meal as a fish meal component was analysed in research paper "*Insect Meal in the Fish Diet and Feeding Cost: First Economic Simulations on European Sea bass Farming by a Case Study in Italy*" by Pulina, Arru, Madau, Furesi, Gasco. Insect feed could account for up to 3% of the entire production of feed market within the next four years (Arcluster, 2017).

Insect larvae meal contains things which might increase fish and poultry quality, thus increasing the product value (Al-Qazzaz et.al, 2016).

Adding insect larvae meal by 3-5%, which contains high quality proteins, and insect larvae meal product might apply for biological feed certificate if the mussel is used as the only ingredient. It will impact the price of fish meal by 15-27%.

From the point of consumers, among the attributes that determine the consumption of fish, it leaves a positive impact on health and nutritional beliefs (Carlucci et al., 2015).

Cost benefit for local community tax payments

The development of a new sector creates new jobs and payments in the state and municipal budgets in the form of taxes and duties.

Tax payments were calculated based on salaries of personnel involved in the processing of blue mussel to obtain insect larvae meal, so the amount of tax payments can be calculated according to the expected workload and forecasted expenses.

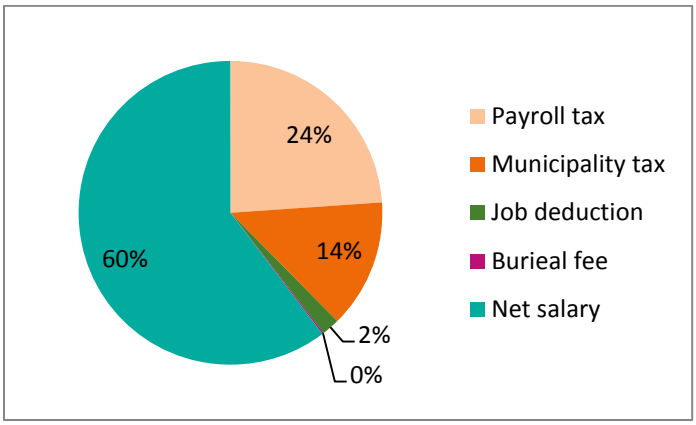

Figure 4 Tax payment applied on salary in Sweden in 2019 (Statsskuld, 2019)

Around 6.6 TEUR will be paid in the state and local government budget upon the labour cost, constituting 42% (Social tax 24%, municipality tax 15%, 2% as job deduction payment).

Municipality tax rate differs among municipalities in Sweden.

International trade balance of blue mussel in the Baltic Sea region

In order to analyse the import and export trade balance of blue mussels, mostly used as food in the Baltic Sea region, statistical information was selected (Combined Nomenclature – eight codes).

The following codes were selected for the analysis:

- CN03073110
- CN03073210
- CN03073920
- CN03073990
- CN16055310
- CN16055390
- CN16055900

Table 15 Import and export trade balance of mussel in the Baltic Sea region countries (kg)

Country	Year	Export			Import		
		to BSR countries	Europe, rest of BSR	Outside Europe	From BSR countries	From Europe, rest of BSR	Outside Europe
Finland	2016	0			256 000		
Denmark	2016	8 149 529	15 188 245	96 908	46 786	178 297	1 241 976
Germany	2018	18 843 200			12 080 800		
Estonia	2018	92 117	33 432	80 262	54 339	18 963	
Latvia	2018	136 014	570	3 237	149 166	114 197	1 000
Lithuania	2018	15 037	106	21 021	0	159 311	147 377
Poland	2016	19 881	74 238	38 476	170 521	462 431	216 461
Sweden	2018	81 000	311 000	1 000	613 000	305 000	211 000
Total		**43 185 273**			**16 426 625**		

Statistical information was collected from the National Statistical Bureaus of each country, except Finland (FAO).

Denmark is in the leading position in the Baltic Sea region in terms of the blue mussel exports within the Baltic Sea region (15188 tonnes) and exports to the rest of Europe (8150 tonnes).

1670 tonnes of mussels of the selected product were imported outside Europe. In order to deliver mussel outside Europe the consignor or consignee should use transportation, e.g., trucks or vessels.

Case study – delivery of blue mussel to Copenhagen

In 2018 in Denmark there were delivered 148 tons of mussel from New Zealand and 858 tons of mussel from Chile. To analyse GHG emission as CO_2 2 different calculation tools were used – EcoTransit and Pier2Pier.

GHG emissions as CO_2

	TSAirplane	*TSSea ship*
Truck	49	*30*
Airplane	21,431	*0*
Sea ship	0	*334*
Sum:	**21,48**	***364***

	TSAirplane	*TSSea ship*
Truck	*24*	*235*
Airplane	*86,975*	*0*
Sea ship	*0*	*1,191*
Sum:	***86,999***	***1,425***

In order to deliver 148 tonnes of mussels by vessels from Wellington to Copenhagen, 48–364 tonnes of CO_2 are emitted (PierPpier.com; ecotransit.org).

In order to deliver 858 tonnes of mussels from Chile to Copenhagen, 187–1425 tonnes of CO_2 are emitted.

The carbon emission price fluctuates – at the beginning of 2019 it was EUR 22 per ton.

Applying carbon emission prise for delivered amount, it is possible to calculate that the increase of price for delivered blue mussel should rise to 0.005-0.05 EUR/kg due to CO_2.

By delivering 148 tons of blue mussel from Stockholm to Copenhagen, 3.7 tons of CO_2 are emitted and it is 12 times less.

The size of imported blue mussel is bigger therefore the local producers can't satisfy the demand for this product however there are huge amount 25894 tons of mussel in pellets unfit for human consumption imported outside of Europe.

Conclusion

Cost benefit analysis of mussel processing revealed that 5 million EUR in investment might not repays, however several scenario analysis has shown potential benefits.

Cost benefit analysis of mussel processing				
Description	*Raw material (blue mussel) purchase price EUR/ton*	*Investment amount, TEUR*	*NPV, TEUR, discount rate 4,4%*	*IRR, %*
Mussel as feed				
Mussel as feed, investment on 10 years	500	5 000	-31000	-
Scenario analysis				
Raw material (blue mussel) purchase price is 80 EUR/ton	80	5 000	-300	-2,9%
Raw material (blue mussel) purchase price is 80 EUR/ton; Harvest losses are estimated at 10% instead of the previous 5%.	80	5 000	-933	-6,2%
Raw material (blue mussel) purchase price is 80 EUR/ton; The project is implemented by attracting the EU Structural Funds, external co-financing amounts to 40%.	80	5 000	1535	6,2%
Investment amount – EUR 2 million, raw material (blue mussel) purchase price is 80 EUR/ton; The project is implemented through the involvement of the EU Structural Funds, external co-financing amounts to 40%.	80	2 000	1158	14,1%
Insect meal processing				
Insect meal, 5 years	50	45	1,7	6,6%
Scenario analysis				
investment period - 10 years	50	71	18	15,7%
Receiving financial support to cover 50% of investment, investment on 5 years	50	45	22	40,2%
Receiving financial support to cover 50% of investment, investment on 10 years	50	71	38	41,4%

Cost benefit analysis revealed that by developing mussel meal processing it is possible to employ 5 part-time employees (3.3 full time employees) or even more. Insect meal processing is possible to realise in smaller scale.

It is possible to reduce carbon footprint by processing and consuming local product. Case study revealed reduction of CO_2 by 10 times.

Today feed industry has a potential to develop due to increasing demand of local and eco-friendly products. Mussel meal and mussel shells are eco-friendly products.

Information from interviews has indicated increasing demand for high quality product is crucial. Potential customer, however pays attention to product price.

Economic benefit

- Eco-friendly product
- Diversification of product
- Development of new businesses
- Partly replacing imported product
- Additional income

Eco-system service

- Reduce nitrogen, phosporus (approx. compensation by reducing nutrients in the Baltic Sea 0.40 EUR/kg per harvested blue mussel)
- Natural recource from the Baltic Sea

Social benefits

- Tax payments in budget :
  - 66 TEUR mussel meal industry
  - 6.6 TEUR - insect larvae meal site
- Increase labourforce in coastal areas

Environmental benefit

- By using local product CO2 emissiong footprint reducesby 10 times or even more.
- Better visability in water

References

Al-Qazzaz MFA, Ismail D, Akit H, Idris LH. 2016. Effect of using insect larvae meal as a complete protein source on quality and productivity characteristics of laying hens. R Bras Zootec. 45:518-523.

Bertilius K. 2018. Baltic Blue Growth internal project report.

Business Wire. Global Poultry Feed Market - Expected to Reach $220 Billion By 2020 - Research and Markets. (2016, February 25). Retrieved from http://www.businesswire.com/news/home/20160225006321/en/Global-Poultry-Feed-Market---Expected-Reach

Carlucci D., Nocella G., De Devitiis B., Viscecchia R., Bimbo F., Nardone G. Consumer purchasing behaviour towards fish and seafood products. Patterns and insights from a sample of international studies. Appetite. 2015;84:212–227.

EcoTransIT (n.d.). https://www.ecotransit.org/calculation.en.html

European Union Regulation (EC) No. 1831/2003 of the European Parliament and the council of 22 September 2003 on additives for use in animal nutrition. eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32003R1831.

FEFAC VISION ON ANIMAL FEED INDUSTRY, 2016. Retrieved from https://www.fefac.eu/files/67546.pdf

Food and Agriculture Organization of the United Nations, 2010. Good practises for the feed industry. FAO. Accessed: 1 December 2018. Available at: http://www.fao.org/3/i1379e/i1379e.pdf

Food and Agriculture Organization of the United Nations, 2015. The Partnership between FAO and the Animal Feed Industry Grows Steadily Stronger. FAO. Accessed: 1 December 2018. Available at:

Gallo, A., Wessel, M., & Gallo, A. (2017, December 06). A Refresher on Net Present Value. Retrieved from https://hbr.org/2014/11/a-refresher-on-net-present-value

Internal Rate of Return (IRR). (n.d.). Retrieved from https://investinganswers.com/financial-dictionary/investing/internal-rate-return-irr-2130

Minnhagen S., Ozolina Z., Emilsson M., Bailey J., 2018/2019. BUSINESS SITUATION ANALYSIS for a mussel farm located in east-coast Sweden. Project Baltic Blue Growth inner report.

Ozolina, Z. 2018. Blue mussel farming costs, production amount and yield in the Baltic Sea. Baltic Blue Growth project report

Palm, O., Lalander, C., Vidakovic, A. 2018. Processing and storage of mussels: mussels to feed through fly larvae.

Pier2Pier (n.d.). Retrieved from https://www.pier2pier.com/Co2/

Poultry Development Review. FAO. 2013. Retrieved from http://www.fao.org/3/i3531e/i3531e.pdf www.fao.org/ag/againfo/home/en/news_archive/2015_FAO_and_the_animal_feed_industry.html.

Pulina, P. & Arru, B. & Madau, F.A. & Furesi, R. & Gasco, L., 2018. "Insect Meal in the Fish Diet and Feeding Cost: First Economic Simulations on European Sea bass Farming by a Case Study in Italy," 2018 Conference, July 28-August 2, 2018, Vancouver, British Columbia 275929, International Association of Agricultural Economists.

Rama-Poccia, M. (2018, December 13). What Is Discounted Cash Flow Valuation? Retrieved from https://www.thestreet.com/investing/what-is-discounted-cash-flow-valuation-dcf-14804771

Salmon farming industry handbook. Marine Harvest. 2018. Retrieved from http://marineharvest.no/globalassets/investors/handbook/2018-salmon-industry-handbook.pdf

THE ANIMAL FEED INDUSTRY's 2030 VISION - Fefac.eu. Accessed: 1 December 2017. Available at:

The International Feed Industry Federation (IFIF). Global Feed Statistics. (n.d.). Retrieved from https://ifif.org/global-feed/statistics/

van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G., Vantomme, P., 2013. Edible insects - Future prospects for food and feed security. FAO Forestry Paper. Retrieved from http://www.fao.org/3/i3253e/i3253e.pdf

Worldwide Insect Feed Market (2017 - 2022): Market Sizes and Forecasts. 2017. Arcluster.

1. Annex

Profit and loss statement of feed industry, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Revenue		**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**
Shell		171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000
Mix		902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500
Mussel powder		665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000
Production cost	55 744	5 372 220	5 378 220	5 380 695	5 380 695	5 380 695	5 383 170	5 383 170	5 383 170	5 383 170
Admin.& Sales costs	2 787	285 996	286 296	286 420	286 420	286 420	286 544	286 544	286 544	286 544
EBITDA	**-58 531**	**-3 919 716**	**-3 926 016**	**-3 928 615**	**-3 928 615**	**-3 928 615**	**-3 931 214**	**-3 931 214**	**-3 931 214**	**-3 931 214**
Depreciation	0	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000
Interest cost	75 000	138 750	116 250	93 750	71 250	48 750	26 250	7 500	0	0
EU support	0	0	0	0	0	0	0	0	0	0
Income tax, 22%		0	0	0	0	0	0	0	0	0
Net profit	**-133 531**	**-4 558 466**	**-4 542 266**	**-4 522 365**	**-4 499 865**	**-4 477 365**	**-4 457 464**	**-4 438 714**	**-4 431 214**	**-4 431 214**

Cash flow, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9*	Y10
CF in the beginning of period	**0**	**866 469**	**-3 941 997**	**-8 734 263**	**-13 506 628**	**-18 256 493**	**-22 983 857**	**-27 691 321**	**-32 130 034**	**-36 061 248**
CF from operating activities	**-133 531**	**-4 058 466**	**-4 042 266**	**-4 022 365**	**-3 999 865**	**-3 977 365**	**-3 957 464**	**-3 938 714**	**-3 931 214**	**-3 931 214**
CF from investment activities	**-5 000 000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CF from financing activities	**6 000 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-500 000**	**0**	**0**
CF at the end of period	**866 469**	**-4 808 466**	**-4 792 266**	**-4 772 365**	**-4 749 865**	**-4 727 365**	**-4 707 464**	**-4 438 714**	**-3 931 214**	**-3 931 214**

* To calculate IRR it was applied correction in Y9 (By amortization).

2. *Annex*

1) Scenario "Raw material (blue mussel) purchase price is 80 EUR/ton"

Profit and loss statement, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Revenue	**0**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**
Shell	0	171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000
Mix	0	902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500
Mussel powder	0	665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000
Production cost	55 744	1 172 220	1 178 220	1 180 695	1 180 695	1 180 695	1 183 170	1 183 170	1 183 170	1 183 170
Admin.& Sales costs	2 787	75 996	76 296	76 420	76 420	76 420	76 544	76 544	76 544	76 544
EBITDA	**-58 531**	**490 284**	**483 984**	**481 385**	**481 385**	**481 385**	**478 787**	**478 787**	**478 787**	**478 787**
Depreciation	0	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000
Interest cost	75 000	138 750	116 250	93 750	71 250	48 750	26 250	7 500	0	0
EU support	0	0	0	0	0	0	0	0	0	0
Income tax, 22%		0	0	0	0	0	0	0	0	0
Net profit	**-133 531**	**-148 466**	**-132 266**	**-112 365**	**-89 865**	**-67 365**	**-47 464**	**-28 714**	**-21 214**	**-21 214**

Cash flow, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9*	Y10
CF in the beginning of period	**0**	**866 469**	**468 003**	**85 737**	**-276 628**	**-616 493**	**-933 857**	**-1 231 321**	**-1 260 034**	**-781 248**
CF from operating activities	**-133 531**	**351 534**	**367 734**	**387 635**	**410 135**	**432 635**	**452 537**	**471 287**	**478 787**	**478 787**
CF from investment activities	**-5 000 000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CF from financing activities	**6 000 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-500 000**	**0**	**0**
CF at the end of period	**866 469**	**-398 466**	**-382 266**	**-362 365**	**-339 865**	**-317 365**	**-297 464**	**-28 714**	**478 787**	**478 787**

* To calculate IRR it was applied correction in Y9 (By amortization).

3. Annex

1) Scenario - Raw material (blue mussel) purchase price is 80 EUR/ton; Harvest losses are assumed to be 10% instead of the previous 5%.

Profit and loss statement, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Revenue	**0**	**1 647 000**	**1 647 000**	**1 647 000**	**1 647 000**	**1 647 000**	**1 647 000**	**1 647 000**	**1 647 000**	**1 647 000**
Shell	0	162 000	162 000	162 000	162 000	162 000	162 000	162 000	162 000	162 000
Mix	0	855 000	855 000	855 000	855 000	855 000	855 000	855 000	855 000	855 000
Mussel powder	0	630 000	630 000	630 000	630 000	630 000	630 000	630 000	630 000	630 000
Production cost	55 744	1 172 220	1 178 220	1 180 695	1 180 695	1 180 695	1 183 170	1 183 170	1 183 170	1 183 170
Admin.& Sales costs	2 787	75 081	75 381	75 505	75 505	75 505	75 629	75 629	75 629	75 629
EBITDA	**-58 531**	**399 699**	**393 399**	**390 800**	**390 800**	**390 800**	**388 202**	**388 202**	**388 202**	**388 202**
Depreciation	0	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000
Interest cost	75 000	138 750	116 250	93 750	71 250	48 750	26 250	7 500	0	0
EU support	0	0	0	0	0	0	0	0	0	0
Income tax, 22%		0	0	0	0	0	0	0	0	0
Net profit	**-133 531**	**-239 051**	**-222 851**	**-202 950**	**-180 450**	**-157 950**	**-138 049**	**-119 299**	**-111 799**	**-111 799**

Cash flow, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9*	Y10
CF in the beginning of period	**0**	**866 469**	**377 418**	**-95 433**	**-548 383**	**-978 833**	**-1 386 782**	**-1 774 831**	**-1 894 129**	**-1 505 928**
CF from operating activities	**-133 531**	**260 949**	**277 149**	**297 050**	**319 550**	**342 050**	**361 952**	**380 702**	**388 202**	**388 202**
CF from investment activities	**-5 000 000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CF from financing activities	**6 000 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-500 000**	**0**	**0**
CF at the end of period	**866 469**	**-489 051**	**-472 851**	**-452 950**	**-430 450**	**-407 950**	**-388 049**	**-119 299**	**388 202**	**388 202**

* To calculate IRR it was applied correction in Y9 (By amortization).

4. Annex

1) Scenario - Raw material (blue mussel) purchase price is 80 EUR/ton; The project is implemented by attracting the EU Structural Funds, external co-financing amount of 40%.

Profit and loss statement, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Revenue	**0**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**
Shell	0	171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000
Mix	0	902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500
Mussel powder	0	665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000
Production cost	55 744	1 172 220	1 178 220	1 180 695	1 180 695	1 180 695	1 183 170	1 183 170	1 183 170	1 183 170
Admin.& Sales costs	2 787	75 996	76 296	76 420	76 420	76 420	76 544	76 544	76 544	76 544
EBITDA	**-58 531**	**490 284**	**483 984**	**481 385**	**481 385**	**481 385**	**478 787**	**478 787**	**478 787**	**478 787**
Depreciation	0	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000
Interest cost	75 000	138 750	116 250	93 750	71 250	48 750	26 250	7 500	0	0
EU support	0	250 000	250 000	250 000	250 000	250 000	250 000	250 000	250 000	0
Income tax, 22%		0	0	0	0	0	0	0	0	0
Net profit	**-133 531**	**101 534**	**117 734**	**137 635**	**160 135**	**182 635**	**202 537**	**221 287**	**228 787**	**-21 214**

Cash flow, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9*	Y10
CF in the beginning of period	**0**	**866 469**	**2 468 003**	**2 085 737**	**1 723 372**	**1 383 507**	**1 066 143**	**768 679**	**739 966**	**1 218 752**
CF from operating activities	**-133 531**	**351 534**	**367 734**	**387 635**	**410 135**	**432 635**	**452 537**	**471 287**	**478 787**	**478 787**
CF from investment activities	**-5 000 000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CF from financing activities	**6 000 000**	**1 250 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-750 000**	**-500 000**	**0**	**0**
CF at the end of period	**866 469**	**1 601 534**	**-382 266**	**-362 365**	**-339 865**	**-317 365**	**-297 464**	**-28 714**	**478 787**	**478 787**

* To calculate IRR it was applied correction in Y9 (By amortization).

5. *Annex*

Scenario Investment cost – EUR 2 million; Raw material (blue mussel) purchase price is 80 EUR/ton; The project is realized with the involvement of the EU structural funds, external co-financing 40%.

Profit and loss statement, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Revenue	**0**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**	**1 738 500**
Shell	0	171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000	171 000
Mix	0	902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500	902 500
Mussel flesh	0	665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000	665 000
Production cost	55 744	1 330 940	1 336 940	1 339 415	1 339 415	1 339 415	1 341 890	1 341 890	1 341 890	1 341 890
Admin.& Sales costs	2 787	83 932	84 232	84 356	84 356	84 356	84 480	84 480	84 480	84 480
EBITDA	**-58 531**	**323 628**	**317 328**	**314 729**	**314 729**	**314 729**	**312 131**	**312 131**	**312 131**	**312 131**
Depreciation	0	200 000	200 000	200 000	200 000	200 000	200 000	200 000	200 000	200 000
Interest cost	30 000	55 500	46 500	37 500	28 500	19 500	10 500	3 000	0	0
EU support	0	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	0
Income tax, 22%		36 988	37 582	38 990	40 970	42 950	44 359	46 009	46 669	24 669
Net profit	**-88 531**	**131 140**	**133 246**	**138 239**	**145 259**	**152 279**	**157 272**	**163 122**	**165 462**	**87 462**

Cash flow, EUR

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9*	Y10
CF in the beginning of period	**0**	**311 469**	**1 042 609**	**975 854**	**914 093**	**859 352**	**811 631**	**768 903**	**832 025**	**1 097 486**
CF from operating activities	**-88 531**	**231 140**	**233 246**	**238 239**	**245 259**	**252 279**	**257 272**	**263 122**	**265 462**	**287 462**
CF from investment activities	**-2 000 000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CF from financing activities	**2 400 000**	**500 000**	**-300 000**	**-300 000**	**-300 000**	**-300 000**	**-300 000**	**-200 000**	**0**	**0**
CF at the end of period	**311 469**	**731 140**	**-66 754**	**-61 761**	**-54 741**	**-47 721**	**-42 728**	**63 122**	**265 462**	**287 462**

* To calculate IRR it was applied correction in Y9 (By amortization).

About

Baltic Blue Growth is a three-year project financed by the European Regional Development Fund. The objective of the project is to remove nutrients from the Baltic Sea by farming and harvesting blue mussels. The farmed mussels will be used for the production of mussel meal, to be used in the feed industry. 18 partners from 7 countries are participating, with representatives from regional and national authorities, research institutions and private companies. The project is coordinated by Region Östergötland (Sweden) and has a total budget of 4,7 M€.

Partners

- *Region Östergötland (SE)*
- *County Administrative Board of Kalmar County (SE)€*
- *East regional Aquaculture Center VCO (SE)*
- *Kalmar municipality (SE)*
- *Kurzeme Planning Region (LV)*
- *Maritime Institute in Gdańsk (PL)*
- *Ministry of Energy, Agriculture, Environment and Rural Areas (DE)*
- *Municipality of Borgholm (DK)*
- *SUBMARINER Network for Blue Growth EEIG (DE)*
- *Swedish University of Agricultural Sciences (SE)*
- *County Administrative Board of Östergötland (SE)*
- *University of Tartu (EE)*
- *Coastal Research and Management (DE)*
- *Orbicon Ltd. (DK)*
- *Musholm Inc (DK)*
- *Coastal Union Germany EUCC (DE)*
- *Swedish Institute of Agricultural and Environmental Engineering JTI (SE)*