E. c(oil)i

A Business Plan for a Synthetic Palm Oil

MANCHESTER 1824
The University of Manchester

Executive Summary

E. c(oil)i's main goal is to provide a synthetic palm oil for our consumers in a way that is more sustainable, and more cost effective than our competitors. We will be able to supply them with palm oil which is much cheaper than competitors through our use of a vat-based fermentation process rather than adopting the traditional production process of buying up vast expanses of forested land to convert to palm oil plantations.

Our focus will predominantly be on business to business selling whereby we will work as a manufacturer.

E. c(oil)i will operate from one major site in Malaysia which will encompass multiple large vats and outlying buildings for admin and research purposes. Reasons behind this choice in location are detailed in our Impact Analysis Report. This facility will serve as a center for distributing our palm oil to shipping ports where it can be shipped around the world to companies such as Unilever.

Our unique selling point of producing a more environmentally friendly alternative to naturally grown palm oil will be the driving force behind generating interest and sales from consumers and manufacturers. Their policies to use more environmentally friendly palm oil will ensure their repeat business, which our business will rely upon. We expect that, as arable land continues to dwindle in palm oil producing countries and the price of palm oil continues to soar, *E. c(oil)i* will appeal more and more to customers' sense of convenience and value.

Costs will be minimized by maintaining only a short supply chain from *E. c(oil)i*, the producer, through to consumer. We will rely on only a medium sized labour force to further reduce costs.

Objectives

E. c(oil)i has identified the following objectives to pursue in the upcoming years:

- Become a major player in the palm oil industry
- Have our business be the go-to place to purchase cheap, environmentally friendly palm oil
- Reach profitability within 70 months from when we start full production of our product.

Mission Statement

E. c(oil)i's mission is to meet customers' increasing demands for a more sustainable palm oil by providing them with a clean, more environmentally friendly alternative.

Keys To Success

Our key to making this venture a success are:

- Maintaining our core-values to only provide a more sustainable alternative to the palm oil produced by competitors
- Maintain low operating costs.
- Keep the supply chain to a minimum number of steps to ensure convenience for our target market.

Company Summary

Company History

The company is the brainchild of a group of university students primarily from the University of Manchester. The team has spent, in total, hundreds of man hours in the research and the development of the product and the method of production to get it how it is in its current form.

To date the team has developed a fully functional method to produce this synthetic palm oil from utilising *E. coli* to produce the components of palm oil. Work has also been done surrounding the potential of assigning intellectual property rights to the production process we have been utilising to produce our product.

As a team largely composed of personnel who are experienced and educated in the field of science and synthetic biology, together we form a powerful unit.

Company Ownership

The company will be owned by the ten group members and the University of Manchester, each holding equal shares. Due to countries such as Malaysia being largely economically dependent on the current cultivation and processing of palm oil, the team is eager to minimise the impact this business would have on these countries. For this reason, licences to use the business would be offered to the Malaysian government at a negotiated price that would reflect the current value of palm oil. The Malaysian government would then be permitted to use the processes involved in *E. c(oil)i* to continue to profit from trade in palm oil components. It is predicted that replacing traditional methods of palm oil production with *E. c(oil)i* would support the economy of Malaysia.

It is hoped that the costs for running *E. c(oil)i* would be reduced when the business is operating in Malaysia due to differences in staffing costs and utilities bills.

Product

E. c(oil)i will offer the supply of lab-produced synthetic palm oil to companies around the world. Production will be based on-site in Malaysia in a major complex located near to a shipping port to minimize the transport costs associated with getting the palm oil from the factory to a position where it can be transported to our customers.

Our distinctive unique selling point of providing an environmentally less destructive alternative to current methods of palm oil production will be sufficient enough to secure *E. c(oil)i*'s survival in a competitive market.

Market Analysis Summary

We are a highly technical niche player offering the supply of strong product that is in great demand. We have identified that our target market are the brokers and distributors who have established relationships with large corporations who order palm oil on mass to be utilised in the production of their own goods for resale.

Market Segmentation

We have identified the following segments which make up our market:

- **Biofuel manufacturers and distributors**: our potential customers in this segment include Renovatio Energy LLC and IOI Group. As members of the Roundtable on Sustainable Palm Oil, these companies support the manufacturing of palm oil which is not environmentally damaging.
- **Cosmetics manufacturers**: our potential customers in this segment include L'oreal and Henkel. Both of these brands have made a commitment to use only sustainable palm oil in the production of their cosmetics.
- **Food manufacturers**: our potential customers in the segment include Hain Daniels and Eccelso. These two companies have expressed an interest in our product by offering funding to help make the venture a success.

Target Market Segment Analysis

Biofuel Industry: This is potentially our greatest market opportunity. Biofuel is a growing market in terms of its palm oil use: palm oil is now thought to compose at least 20% and the use of palm oil in biofuel in the EU alone is projected to reach 2.7 million tonnes by 2020. This has forced many governments to seek a more sustainable palm oil supply chain. Therefore it seems logical to exploit this opportunity and devote the majority of our time and palm oil supply meeting this demand. This market will potentially be the basis of our growth.

Personal Care Industry: Palm oil and associated products are present in over 70% of cosmetic products. The growing demand for personal care products has contributed to the increased level of deforestation. There seems to be a lack of communication of what pertains to palm oil products in this industry. For example, customers who avoid palm oil may be shocked to know that a chemical used in cosmetics called Sodium Laureth Sulfate is derived from products associated with palm oil. We believe that our product is particularly suitable to the personal care industry as they are often only interested in certain components of the oil. Using our three batch system, we are able to create components of palm oil individually, reducing the amount of time and money spent purifying the products.

Food Production Industry: Here, we have acknowledged that our product does not hold as much potential compared to our other two target markets. We have factored in the public's generally negative attitude towards genetically modified foodstuffs in this conclusion. However, as available arable land becomes less and less food manufacturers may have no choice but to utilise our palm oil in their production processes. The food industry has already shown an interest in a synthetically produced palm oil, with two companies financially supporting the preliminary research carried out in this project. With a strong marketing campaign aimed at the public emphasising the safety of consuming a genetically modified palm oil we believe that capturing a percentage of this market to be possible.

Industry Analysis

The palm oil industry is characterised by a multi-step supply chain: Smallholders and large estate holders, millers, refiners, traders, manufacturers, retailer. Unlike the end consumer, the big purchasing bodies of palm oil have full visibility of the supply chain.

Sales and Implementation Summary

Our marketing strategy assumes we will serve our customers in the following way:

- **Trade Supplier**: In this we will produce and sell our own line of product which we have developed based on the needs and wants of manufacturers and end consumers alike.

Competitive Edge

E. c(oil)i's competitive advantage lies in its revolutionary approach to the production of palm oil. This method is more sustainable and more cost effective which makes it considerably more appealing to customers' specific needs compared to traditional methods of production. We are able to benefit from a smaller supply chain by eradicating the need for growers of oil palm fruit and subsequently the need to extract the oil from the fruit in mills. In effect, the start of the supply chain for our product is the refining stage for natural palm oil. Thus *E. c(oil)i's* supply chain will consist of only 4 steps instead of the usual 6. This serves as an advantage as a shorter supply chain means there are less people wanting to make profits along the process from palm oil grower to the eventual retailing body, and therefore there is an opportunity to supply the product at a reduced rate. Because our production method is so innovative, we have looked into the possibilities of assigning intellectual property rights to our production process to ensure we maintain a strong competitive edge.

Sales Strategy

We will commence with our sales strategy once the facility is built and is in operation. This allows us to accept new clients who have an interest in the distribution of a synthetic palm oil and allows us to accommodate any orders they might have. We have already had interest in our venture, largely from the food industry.

Financial Summary

Construction Costs

We have based the size of our plant based on current sizes for large-scale synthetic biology plants. Largely, we have based this on the Eli Lilly insulin plant in Indianapolis [1], which contains 5000 50,000L fermenters, alongside purification and packing facilities, over a 12.8 hectare site.

As the costs of construction for this site were around $140 million, we would expect similar equipment costs for our facilities. We would also like to build solar panels across our 12.8 hectare site to provide some of the energy needed for our processes, in keeping with our environmental concerns. This will add $15.95million to our construction costs.

Feedstock Costs

Although preliminary research has been based on the use of glucose as a feedstock for our palm oil producing *E. coli*, in large scale production this would not be economically viable. Therefore, we propose an alternative method of feeding *E. coli*.

Waste agricultural biomass is a cellulose rich commodity that is widely underutilised by industry. With an average price of around $50 to $60 per dry tonne [2], it is also a relatively cheap means of feeding *E. coli*.

E. coli itself does not have the means to break down this cellulose into anything usable by the cell. However, progressions in synthetic biology are beginning to open up the possibilities to be able to use cellulose as feedstock. This can be done in one of two ways:

1) Introducing a series of enzymes that are able to catalyse the breakdown of cellulose into usable compounds in *E. coli.* [3]

2) Incorporating *E. coli* into a consortium with a fungi, in order to harness the natural cellulose catalysing abilities of these organisms to feed the *E. coli.* [4]

Both of these methods, on a “proof of principle” level, have been shown to facilitate normal growth of *E. coli*, and production of useful compounds, without the need for a glucose feedstock.

As waste agricultural biomass is around 40 - 50% cellulose, in order to get an output mirroring that which we think is an achievable level of production of palm oil using E. coli (see *Output*) our calculations show that we would need 27 tonnes of waste agricultural material per 5000L fermenter per month. At a cost of $60 per dry tonne, this would be $1620 per month per fermenter.

We believe that feeding the *E. coli* this level of cellulose is sustainable, as, although we would consume 162 tonnes of biomass annually per fermenter, 140 billion tonnes of agricultural biomass waste is produced annually.

The primary advantage to using this method to feed our *E. coli* is clear - Cellulose is the most abundant organic polymer on Earth and reduces the need for expensive glucose. However, we would have to consider the effect that feeding the *E. coli* in this way would have on the rate at which our *E. coli* system could produce the components of palm oil. This is addressed in our output section.

Utilities Costs

We have estimated our water usage based on bioethanol plants, where 2 gallons of unrecyclable fresh water are produced for every gallon of ethanol produced. Therefore, for each fermenter we would need 84 gallons of fresh water per month. In the UK, 220 gallons of water costs £1.20. Therefore, we would expect to use 0.45p ($0.73) worth of water per fermenter per month.

Construction of solar panels across the site will provide around 4 MW of electricity. This will generate around half of the energy required.

As the products produced on our plant can be directly used as biofuels, we would suggest that we could use some of our fatty acids to power our facility, which is common on bioethanol facilities. In many cases, these plants do not have to use any energy from the national grid. Therefore, the remainder of our electricity requirement will come from the redirection of 14% of our product into electricity production for the site.

Staffing Costs

We estimate that the staffing requirements for a venture of this size will be:

Position	Average Salary (USD/annum)	Number	Total cost (USD/annum)
Technician			
Plant manager	$90000	4	$360000
Plant engineer	$46374	4	$185496
Maintenance supervisor	$42651	4	$170604
Lab manager	$46695	4	$186780
Shift supervisor	$56069	20	$1121380
Lab technician	$28031	8	$224244
Maintenance technician	$33726	36	$1214136
Shift operators	$39000	80	$3120000
Researchers	$40000	15	$600000
Non-technician			
General labourer	$25000	67	$1675000
Total cost per annum			$8857640

Source of Information: Payscale [5]

Output

Studies on the fatty acid producing module that we have used show that 0.124g of fatty acids can be produced per litre over one hour [6]. This means that, per month, each 50,000L fermentor could produce 4465 kg of palm oil.

However, this figure has been calculated using glucose as a feedstock. We would suggest that it is significantly more economically viable to use waste agricultural material as a feedstock for our system (See *Feedstock Costs*). However, this is likely to impact on the efficiency of our system to produce these fatty acids. If we assume an *E.coli*/fungi innoculation ratio of 1, we can assume a maximum 62% efficiency of conversion from carbon source to desired fatty acid product, should we use a fungal consortium [7]. This means that, conservatively, we would expect to see around 2768.3kg of palm oil produced.

At a current market price of $784 per tonne for palm oil [8] (it is important to note that this price is increasing rapidly - doubling in the last ten years despite government interventions), this would be $2170.35 per fermenter per month. However, Sustainably produced palm oil fetches a premium of $3 extra per tonne in order to incentivise growers to adopt sustainable practices. With this additional $3 per tonne increase we would expect the fermenters to generate $2178.66.

However, as 14% of our product is reused on site as biofuel, we have reduced this number by 14% for our costs summary.

Summary of Finances

Across a 12.8 hectare plant containing 5000 50,000L fermentors (see *Eli Lilly Indianapolis Insulin Plant*), we would expect to see (per month):

Feedstock costs *if using Agricultural Waste* (million USD)	Water (million USD)	Labour (million USD)	Output (million USD)
8.1	0.0036	0.738	9.374
		Total Profit/Loss:	0.5324

Of course, there are other costs, such as transportation and sales, which we are unable to account for at this time. However, with an estimated $532,400 surplus per month, we believe that even with these additional costs, we have created an economically viable product. It is also important to consider that, should we move this industry back to Malaysia, we would expect running costs to decrease.

At this level of output, we would be looking at a payback period of around 300 months (25 years) after the original $155.95 million outlay.

However, it is extremely possible that we will see massive increases in the price of palm oil over the next few decades (Reasons for this are detailed in our *Impact Analysis Report*). This increase would see the profits of this venture rocket - a very modest (and extremely likely) increase of just $10 would see the profits increase by over $138000.

Another factor to consider is that our product will have already skipped many of the refinement processes necessary for use of the palm oil. As refined palm oil currently has a price of $910, it is possible to suggest that the price of our palm oil would actually be much closer to this figure, as we have already separated out the fatty acids in our 3 batch process

and further decontamination steps. At a retail price of $910 per tonne, would lead to over a $2 million increase in profit at a plant of this size. This would reduce the payback period to just 61 months (5 years), making this a very appealing economic investment.

The Bigger Picture

As well as providing a viable economic investment, we believe our venture genuinely provides the opportunity to save the rainforest.
A 12.8 hectare plant has the capability of producing 13841500 kg of palm oil per month. Considering that producing palm oil traditionally provides yields of around 320 kg per hectare per month,we can produce the equivalent of more than 43,000 hectares worth of plantations on just 12.8 hectares.

By just building 5 of these plants per year, we could change 180,000 hectares of lost rainforest, to using 64 hectares of any land to provide the same amount of product.

Every person in the world is thought to consume 7 kg of palm oil annually. This makes a approximately 49 billion kgs consumed per year. This means that it would take 295 plants of this kind to completely replace palm oil industry.

Using just 3776 hectares, we could eliminate the need for the traditionally grown palm oil industry, and the mass deforestation it causes.

References

[1] http://www.diabetesforecast.org/2013/jul/making-insulin.html

[2] http://www1.eere.energy.gov/bioenergy/pdfs/btu_crop_residues.pdf

[3] http://aem.asm.org/content/77/17/6265

[4] http://www.ncbi.nlm.nih.gov/pubmed/23959872

[5] http://www.payscale.com/salaries/a3f627c8/Biological-ScienceLaboratoryTechnician-UK-Salary

[6] http://www.ncbi.nlm.nih.gov/pubmed/23361000

[7] http://www.ncbi.nlm.nih.gov/pubmed/23959872

[8] http://www.palmoilhq.com/

Sponsors


Manchester Institute
of Biotechnology
Discovery through innovation


MANCHESTER
1824
The University of Manchester


uclan
University of Central Lancashire


University of
HUDDERSFIELD


HAIN
DANIELS
GROUP


Eccelso
Excellence in Food


life
technologies™


ERA
SynBio


QIAGEN