

CIRCULAR ECONOMY CASE STUDY: ENTERRA FEED CORPORATION



Canada united in the achievement of zero waste, now and for future generations

GENERAL INFORMATION

- Private company founded in 2007
- Agriculture sector
- Located in Vancouver, BC; global market
- 32 employees
- www.enterrafeed.com



EXECUTIVE SUMMARY

Founded on a disruptive vision to transform the aquaculture and organics disposal industries, Enterra diverts recycled food products and converts it into ingredients for food production. Rising global demand for fish and poultry is placing increased pressure on food inputs and costs. At the same time over 30% of the world's food supply is sent to disposal or composting with considerable loss of complex food nutrients. Enterra Feed Corporation addresses both issues by up-cycling waste food to grow sustainable protein, oil and natural fertilizer products for use in food production – which the company calls “Renewable Food for Animals and Plants™”.

Enterra uses larvae of a local beneficial insect, the black soldier fly, developed in its hatchery, to up-cycle complex nutrients from pre-consumer food discards. After consuming the waste food (feedstock), primarily fruit and vegetable discards, the larvae are harvested and processed into ingredients for fish, livestock and pet feed which substitutes for costly and resource-intensive ingredients, such as fishmeal, poultry meal and soybean meal. Enterra's natural process also creates an organic fertilizer which can replace chemical fertilizers. The company is undergoing rapid expansion and plans to process a total of 1,000 tonnes of food discards per day by 2016 from its existing and planned facilities.

START UP

The idea of using insects to feed fish was born in a conversation between well-known scientist, Dr. David Suzuki, and the company's founder, Brad Marchant, on a rafting trip in 2007. Dr. Suzuki shared his concerns about the depletion of wild fish stocks and their use as aquaculture feed with Brad, a lifelong entrepreneur. Asked what would be better, David pointed to the end of his fishing rod and replied: “How about insects and their larvae?” This was the genesis of Renewable Food for Animals and Plants™ and launched a seven year journey to build Enterra Feed Corporation².

Resource Recovery: The recovery of useful resources and value at the end of one product lifecycle feeds into another, transforming waste into value through innovative recycling and upcycling. Solutions include industrial symbiosis, integrated closed-loop recycling to Cradle-to-Cradle designs where disposed products can be reprocessed into new products¹.

1 Accenture. (2014) Circular Advantage: Innovative Business Models and Technologies to Create value in a World without Limits to Growth.

2 Dr. Suzuki donated his share of the company to the David Suzuki Foundation.



Enterra collects pre-consumer fruit and vegetable waste³ from sustainably minded grocers, food distributors and food processors — including Overwaitea Food Group, T&T Supermarket Inc., Star Produce Ltd, and Sun Processing — combines it with a small amount of fish trim and waste grains and feeds it to the larvae of the black soldier fly, a common insect indigenous to North America. Since 2009, Enterra's scientists have successfully developed and tested — at the laboratory, pilot, demonstration and now commercial scale — hatchery modules which provide a fully controlled, artificial environment optimized for the life-cycle of this beneficial, non-invasive insect. In a few years the scientific team found a way to domesticate a natural process — mimicking nature's way of up-cycling waste organics. Like any farming operation with a hatchery, Enterra's process is now highly controlled and automated. During the demonstration phase, Enterra determined the operating costs, validated the modular approach and proved its scalability.

While other companies use insect-rearing technologies to consume waste food, none are using primarily fruit and vegetable discards, which is the largest source of waste food globally. Enterra is the first company in the world to develop a technology at a commercial scale that up-cycles fruits and vegetables to produce animal protein and oil. Many animals don't eat fruit and vegetables but readily eat insect larvae — Enterra has pioneered a means to domesticate insect production to grow feed ingredients.

The patent pending technology — a commercial scale natural hatchery system — has been developed by Enterra at numerous locations in Vancouver since 2009, from early stage conceptual laboratory experiments to a demonstration plant for testing its commercial scale modules.

In 2014 the company moved its farming operations to Langley, BC, near Vancouver, and has ramped up production capacity to divert 100 tonnes per day of waste food (feedstock) from other disposal alternatives such as landfills, composting and waste-to-energy facilities. 100 tonnes per day feedstock capacity, which contains approximately 25 tonnes of dry waste food, produces approximately 7 tonnes per day of protein and oil feed ingredients and 8 tonnes per day of organic natural fertilizer. Enterra's technology results in approximately double the utilization of the food nutrients compared to anaerobic digestion (waste-to-energy) and three times the revenue stream, and approximately 5 times the resource utilization of composting with significantly higher revenues.

While preventing waste food or donating unused food to food banks are preferred strategies, the waste food inputs used in Enterra's processes are not approved for human consumption, making insect feedstock the highest value, most efficient conversion of the nutrients in waste food.

At full capacity, Enterra's 56,000 square foot facility in Langley will contain about 8 million black soldier flies as a broodstock for the production of larvae. For comparison, a typical one acre of farmland in Langley will contain about 400 million insects, weighing about 200 kilograms — or about the same as 75 boiler chickens.

The firm has received permission to sell its larvae product in Washington State, Oregon, California, Illinois and Idaho. It is still working on permissions in Indiana and Utah and has an application pending with the Canadian Food Inspection Agency (CFIA) to sell aquaculture and poultry feed ingredients in Canada. The CFIA regulates all recycled food products as well as all new feed ingredients used in the preparation of feed for aquaculture, poultry and livestock in Canada, to insure that product efficacy, toxicity and safety meet current Canadian feed guidelines.

In the early days of developing its model Enterra had to determine where and how to acquire its feedstock (recycled food products): where is it, how do you get it and move it and how and what do you pay for it? This was the biggest challenge they faced in launching the business.

³ The company does not accept household or institutional food waste, yard waste, municipal waste, garbage or manure.

Their main sources of feedstock are the larger food processors, food packagers and large retail grocery stores in Metro Vancouver, all of whom are interested in more sustainable solutions for their waste food. Enterra is able to accept their waste food at a much lower cost compared to the other organics diversion options. However, as there is no consistency, each contract is unique. It is an ongoing challenge to secure the feedstock because it has become a complicated market, with composters, anaerobic digesters and haulers having diverse interests, some of them aggressively competitive.

Some of the feedstock comes packaged, including about 30% plastic packaging. Enterra has its own de-packaging machinery, which it bought commercially. All of the packaging gets recycled through local recycling operators – a group Enterra had to research and engage in order to ensure its production process generates zero waste. The technology itself produces no waste products and does not generate any negative environmental impacts.

“Entomology” + “Earth” = Enterra

(Entomology is the study of insects)

Enterra doesn't do its own hauling but works with haulers to transport the feedstock to its facilities – all of whom can gain financial and reputational benefits by diverting organic waste to the company. It has a vision to work with local companies diverting locally produced food to create local feed ingredients and fertilizer for the local agriculture industry.

The company has been hampered in its ability to realize its local vision so far because the CFIA has not yet approved the feedstock for sale in Canada, although Enterra has been making submissions for three years. The evaluation – when it happens – is expected to be positive because it is a natural product that fish and chickens normally eat in the wild, the pre-consumer recycled food products that Enterra uses as feedstock has already been regulated by the CFIA, and no chemicals are added in the Enterra process. In the meantime, the company is successfully selling its feed ingredients in the US and its organic fertilizer in Metro Vancouver; the latter has been registered in Canada for specialty fertilizer sales. Its natural fertilizer product is certified “organic” and is approved for sale in the USA and Canada. It is able to sell feed ingredients locally for pet food because this does not require CFIA approval.

The commercial facility in Langley is targeting profitability in 2015.



Photo - Paul West

HOW THE BLACK SOLDIER FLIES CONSUME RECYCLED FOOD

Enterra maintains a hatchery operation where insect larvae are hatched from eggs. Enterra then grows the larvae with feedstock derived from clean, traceable organics. The farm operation uses the larval stage of an insect species commonly found in nature as part of the “clean-up crew”. The black soldier fly does not feed as an adult and, as a result, is not considered a pest or carrier of disease. More importantly, the larval stage of the insect's life-cycle is rich in natural protein and oils that can be used to feed fish, livestock and pets. The larvae consume each successive wave of feedstock in a few hours, so the food never has time to decay – there are no rotting smells at Enterra, which are typically associated with transfer stations, landfills and other garbage operations, because the material is consumed before it undergoes bacterial degradation. After two weeks of continuous feeding the mature larvae are harvested, washed, cooked, and dried – producing nutritious, sustainable animal protein and oil products as replacements for costly, resource-intensive and variable-quality wild-caught fish and soybean ingredients in animal and aquaculture feed. The end products include dried larvae, which can be sold “as-is” or further processed to produce meal, that contains about 60% protein, and a natural oil product containing 99.9% lipid products, including omega 3, 6, and 9 essential fatty acids. The dried larvae, the meal and the oils can all be utilized as ingredients in feeds suitable for fish, poultry, zoo animals and pets.

The larvae castings, or “frass”, is the only other product produced from the recycled food products. It is turned into a high-value natural fertilizer product containing 10% N-P-K – typically used as a soil conditioner to promote early stage plant growth. The natural fertilizer has been successfully tested by local and organic farmers, demonstrating it can naturally prevent pests and fungus, adding to the company's product range.

CUSTOMER RECEPTION

The company has various customer segments given its business model and place in the waste food and feed ingredients value chain. It earns revenues from product sales and feedstock processing fees, with customers on the input side (large food processors and grocery retailers who provide the waste food) and the product side. Both the product and feedstock customers are currently served by two sales people.

Enterra has almost 100% success in securing contracts with the waste food generators. Some food processors and retailers are locked into five year contracts, in which case Enterra re-approaches them during contract renewal. Haulers are another customer and they are not resistant to this new hauling model, which typically results in increased density and loads for them.

Enterra provides an optional full concierge service for traceable, pre-consumer waste food diversion, collection and up-cycling to valuable nutrient products. The service includes staff training for the waste generator, signage, and infrastructure to provide organics separation at source. In the early days this service was essential to help food processors and grocery retailers overcome initial waste food diversion operational challenges. Fewer than 25% of customers use the service now that most have established their own processes.

Enterra's value for the product customer is a combination of financial, social and environmental benefits:

The company's game-changing technology sustainably produces local, predictable supplies of high quality protein, natural oils, and organic natural fertilizer, at a stable price and supply, with a better environmental footprint than competing products or processes. Enterra closes the loop on waste food by up-cycling valuable food nutrients that are otherwise lost to landfills and composting operations, with considerable loss of the complex food nutrients. Enterra's hatchery process can process large quantities of feedstock in a fraction of the time of composting, and the animal feed ingredients and concentrated natural fertilizer products provide a substantial value improvement compared to composting and anaerobic digestion technologies that rely on high tipping fees, high electricity rates, or government subsidies to operate.

CUSTOMER BENEFITS

- **Consistent quality** – products have high-quality, consistent nutrient profiles
- **Reliable supply** – operates through all seasons to provide guaranteed quantities and reduces dependence on increasingly scarce natural resources
- **Long term pricing** – offers long term supply contracts for products and helps avoid price volatility
- **Brand and reputation** – creates a sustainability story it can tell customers
- **Cost-savings** – lower cost for organics diversion

The company has acquired about ten customers for its main protein product. Its first was Taplow Feeds, a local privately owned manufacturer of aquaculture feed and specialty pet food. Taplow Feeds is a preferential customer, both because they are local and because they provided considerable advice on how to make Enterra's products suitable for animal feeds in the research and development phase. Taplow Feeds was an early adopter of the product as a forward thinking company wanting to be part of the new trend to insect feed.

Enterra has signed a 5 -year "Off-Take agreement" with Taplow Feeds (an agreement between a producer of a resource and a buyer of a resource to purchase portions of the producer's future production.) Enterra currently sells feedstock to Taplow Feeds for use in pet food.

Enterra sells all of its organic fertilizer product to BioFert, a Canadian manufacturer of organic fertilizer products with global market presence.

The company hasn't experienced any sales barriers with its primary product, the dried larvae, except for registration in Canada by CFIA.

PARTNERS AND COLLABORATORS

Enterra benefited from a number of government, academic and business partnerships during its start-up and testing phase:

- Worked closely with the City of Vancouver to find a suitable site for the demonstration plant; as the technology was untested it was important to find the best location for the facility



- Metro Vancouver provided information, advice and technical assistance in acceptable organics diversion practices
- National Research Council's Industrial Research Assistance Program (federal government program) were early stage partners providing \$450,000 in financial support over 2009 to 2013, a critical investment which offset some of the high-risk costs such as early-stage hiring staff, without which Enterra might not have launched
- Agriculture Canada and Kwantlen University helped to test the natural fertilizer product in field trials
- Skretting, the world's largest feed manufacturer for the aquaculture industry and interested in future opportunities to include insect protein as part of their product offerings, helped Enterra test their product with fish in field trials
- Taplow Feeds, mentioned earlier, is also interested in the market growth potential of insect proteins and has provided advice during the trial period.

GROWTH AND DEVELOPMENT

In 2013 Enterra researched potential private equity investors to fund their commercial growth phase. They approached Avrio Capital, a Calgary-based agricultural fund investing in innovative food and agriculture companies that provide solutions to global challenges in the areas of health, wellness and sustainability. Avrio was an attractive financial partner because of its strategic focus in food and feed ingredients as well as considerable fertilizer and greenhouse network and expertise.

In spring 2014, in return for a 30% equity stake, Avrio Capital provided Enterra \$5M in funding to complete construction of the company's commercial facility in Langley, expand production and begin selling feed on a commercial scale. At full capacity, the facility will process (divert) up to 54,000 tonnes of pre-consumer feedstock each year, helping many local food producers, grocery stores and others comply with Metro Vancouver's 2015 ban on the disposal of food and other organics into its waste stream. The company continues to pilot new sources of pre-consumer recycled food products in the region as it ramps up its production capacity. (There are no plans for using post-consumer waste, as this is against government regulations to use the resultant products as feed ingredients for aquaculture and poultry feed.)

Enterra approached a second strategic investor – UK venture capital firm Wheatsheaf Investments – for another round of financing. The private equity firm invests in businesses that “contribute solutions to growing demands for food, energy and water given the increasingly resource constrained environment as a result of a rapidly changing world population and more affluent communities”. Like Avrio, Wheatsheaf is another value-added investor because of its existing technology knowledge base and the potential for synergistic partnerships with other companies in Wheatsheaf's investment portfolio. In the fall of 2014 the venture capital company also committed \$5M to finance the expansion of the Langley facility. Wheatsheaf received a 20% stake in the company in exchange for its investment.

To date Enterra has invested \$15M to grow the company, of which \$10M was used to build the Langley facility. The company's founders invested the original \$5M, including some federal government seed money.

Enterra plans to expand to 150 tonnes per day waste food capacity (54,000 tonnes per year) in 2015 at its Langley facility and plans to expand its operations to other locations to process 1,000 tonnes of waste per day by 2016.

The company's strategy is to build, own and operate the initial commercial production facilities with a central hatchery in Vancouver. It foresees expanding operations and sales into other cities across Canada and into the United States and Europe through joint ventures. Existing partnerships with national or multinational food chains can be replicated in other jurisdictions helping realize a scalable business model for Enterra. In the longer term, the company is considering licensing the technology as a future growth opportunity. It is currently in discussions with several municipalities and potential joint venture partners in Canada, US and Europe.

SOCIAL AND ENVIRONMENTAL IMPACT

Waste diversion and resource recovery

- In 2015 Enterra expects to divert 36,000 tonnes of organics to its facility, capturing the valuable food nutrients with the potential to divert 1,000 tonnes of waste per day the following year from its existing and planned facilities.

Greenhouse gas emission reductions

- Enterra will be assessing the GHG emission reduction benefits of its technology in 2015 but expects that it will have a lower GHG impact compared to composting or landfill due to the company's minimal machinery requirements, lack of methane production, full diversion of organics and the use of its sustainable products in local food production.

Water benefits

- Enterra does not add any water to grow its "livestock". In fact, it can recover over 5 million gallons of fresh, clean water annually from the fruits and vegetables consumed as feedstock, which is allowed to evaporate at their Langley facility because the water has no local value in Metro Vancouver. When the company opens plants in dry climates it plans to capture the water moisture with a heat pump to reuse it in beneficial ways. (For comparison, to grow 1 pound of beef takes about 1,400 gallons of water.)

Social benefits

- At current capacity the company has created 32 new jobs, all of which are paid well over the minimum wage. Entry level sorting jobs start at 50% over the minimum wage and increase to salaries for financial professionals, engineers and scientists.



Product extensions are also in the works. Research projects are underway to enable the company to further diversify its products. For example, the high-end fatty acids extracted in the creation of the pure protein product can be marketed to other health conscious industries.

Continuous innovation is one of the business benefits realized by Enterra. Innovation generation is a significant opportunity for the company as it identifies new products, technologies and engineering practices with spin-off business potential. The opportunity to contribute to new technology development with global potential is a driver of employee motivation and engagement, as is the company's role in creating solutions to environmental problems. In fact, this is the top reason employees are attracted to work for the company.

Enterra finds both advantages and disadvantages as a first mover in insect proteins as animal feed. As a path finder it must solve various problems such as market acceptance, regulatory barriers and feedstock diversion. However, as a frontier company it is attracting joint ventures and licensing arrangements because of its ability to operate at a commercial scale. Enterra has also benefited from a positive provincial and local government reception, the jurisdictions that encourage green economy solutions.



Developed by the National Zero Waste Council in collaboration with the Ministry of Environment.

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