KULISHA

Kulisha works with food and beverage processing plants to convert their organic waste products into a sustainable insect-based protein for use in animal feeds, as well as an agricultural fertilizer. Our system integrates a type of insect called the black soldier fly into existing food and beverage plants, decreasing disposal costs for the company and creating value from a waste product that would otherwise be discarded.

The Team

Eric Katz
University of Michigan
Business '17

Viraj Sikand
Brown University
Environmental Studies '17

Katie Matton
University of Michigan
Computer Science

Jon Luthy
University of Michigan
Industrial Operations Engineering

Maya Faulstich-Hon
Brown University
Environmental Studies '17.5

Advisors

Raghid Shreih
Google
Program Manager

Phil Taylor
MadAgriculture
CEO

Chrysantus Tanga
Lead Researcher
International Center for Insect Physiology and Ecology

Jeff Tomberlin
Director of FLIES Lab
Texas A&M

As a diverse, interdisciplinary team of students, we have leveraged the resources at our respective universities. In the year and a half since our inception, we have:

- built two fully-functional prototype facilities
- built a diverse network of academic and professional advisors in engineering, entomology, and entrepreneuship
- raised $200,000 of non-dilutive grant funding from a variety of competitions and fellowships, shown below

mbc michigan business challenge

THOUGHT FOR FOOD CHALLENGE

Social Innovation Initiative
Swearer Center
BROWN UNIVERSITY

green light BUSINESS MODEL COMPETITION
port huron

CLINTON GLOBAL INITIATIVE UNIVERSITY

DORIS DUKE CHARITABLE FOUNDATION

The Wicked Problem

Our food systems are extractive.

Rather than cycle nutrients through our food systems, we extract, consume, and waste. One third of the food produced goes to waste while 90% of global fisheries are exploited.

A big reason for this overfishing is that 2/3 of wild fish catch goes towards the production of fishmeal and fish oil, which, in turn, are primarily used as protein for fish, pig, and poultry feeds.

We are feeding fish to other animals, and it doesn't make sense—environmentally or economically.

Why not recycle food waste with insects, and replace fishmeal with those same insects?

and on the other side...

> Food and beverage companies all over the world (and at the 30,000+ plants in the U.S.) produce huge amounts of organic waste

> This waste is rich in nutrients, proteins, carbohydrates, and fats, yet much of it is sent to the landfills; 20% of landfill volume is food waste.

> Negative externalities include GHGs emitted and nutrients lost

Our Circular Solution

A system that allows food and beverage plants to integrate insects into their operations rather than using traditional, expensive, linear disposal methods.

In the process, we produce an insect-based alternative protein from the very insects, called black soldier fly larvae (BSFL), that treat the organic waste. The BSFL are harvested and sold to feed millers as a protein input for animal feeds, providing a sustainable, high quality alternative to fishmeal and recycling nutrients back into the food system. Meanwhile, the insect excrement is sold as a fertilizer.

Why An Insect-Based System?

Unlike crickets, mealworms, and silkworms, black soldier fly larvae aren't picky about what they eat and will consume almost any type of organic waste.

Black soldier fly larvae mature from egg to prepupae in 2 weeks, allowing for high yields and quick turnovers.

Black soldier fly larvae were the first type of insect approved for commercial sale in feeds in North America (July 2016). They are safe to work with and are not vectors of disease.

ENVIRONMENTALLY

2:1 they are very efficient at converting feed into body mass

they consume organic scraps, diverting waste from the landfill

they have an extremely low carbon footprint, and are not resource intensive

Our facility will be built adjacent to food and beverage plants, and we will receive their organic products as the raw inputs to our process. Only the larvae will be present on-site, and there will be no risk of cross-contamination because all larvae will be kept in the enclosed shipping container facility.

As the black soldier fly larvae are grown in modular units, these units can be stacked—creating vertical insect farms that can be scaled across a variety of food and beverage companies, starting with breweries.

The System

Our system is called The Refinery. It is an automated,retrofitted shipping container that takes organic waste as an input and produces sustainable insect protein as an output. The automation is an embedded system that continuously takes measurements of key biological metrics such as temperature, humidity, larval weight and density. In turn, a machine learning software component will be trained to recognize these and adjust feeding and harvest accordingly.

Whole system is on-site, reducing GHG emissions from transport

Refinery is temperature and humidity controlled to optimize larval efficiency

Community of microbes pre-treats waste, breaking down lignin & cellulose and increasing digestibility for insects. Organic slurry is pumped into orange bins.

67.7 m^3

The Circular Economy

Byproducts of food production used as bug food

Bugs used as food for animals

Animals used as food for humans

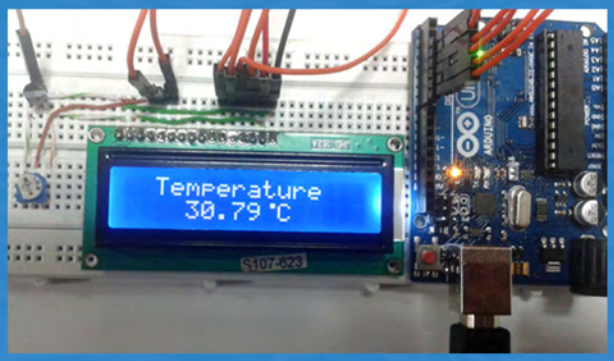
Bugs replace unsustainable fishmeal

Fisheries recover

Challenges

1. Insect Knowledge

We are delving into the brand new sphere of commercial insect production. Black soldier flies have been studied in the lab for decades, but only recently have people started to grow them at scale. We have partnered with widely-renowned black soldier fly researchers at Texas A&M to develop an algorithm that uses machine learning to learn about key parameters of larval growth and will use our first commercial pilot facility to validate biological assumptions.



2. Consistent Feedstock

We require a consistent and reliable source of feedstock in order to maintain a constant throughput of the system. We have recently finalized a deal with a craft brewery in Austin, Texas, to begin construction of a first shipping container facility in June 2017. Through this pilot, we will prove the concept and refine the details about the system flow.

3. Ammonium Buildup

A byproduct of black soldier fly larvae growth is the production of ammonium gas. In enclosed settings, this ammonium can build up rapidly and not only cause terrible odors but cause anoxic environments where larval growth suffers. We are working with two microbiologists to explore types of bacteria to inoculate the waste, predigesting it and reducing the amount of ammonium produced. We will additionally install an HVAC system in the facility to circulate air.

4. Financing

In the long term, food and beverage companies will cover the cost of construction of the facility (about $12,000). We will be incurring the costs of our first facility as well as the initial capital costs for a dryer and a packager. Though we have already raised $210,000 of non-dilutive funding through a variety of competitions and fellowships, we lack the full amount of funds we would like to simultaneously continue development of branding, biological research, and salaries for two additional employees (a process engineer and a marketing and sales expert).

SOURCES CITED

Reports

"Compound Feeds and Additives: Global Markets".
BCC Research, June 2014. Report.

"Insect Proteins for Animal Feed."
Frost & Sullivan, 10 June 2016. Report.

Tacon, Albert GJ, and Marc Metian. "Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: trends and future prospects." Aquaculture 285.1 (2008): 146-158.

Van Huis, Arnold et al. Edible Insects: Future Prospects for Food and Feed Security. Report.

Articles

Burtle, Gary. Mass Production of Black Soldier Fly Prepupae for Aquaculture Diets. University of Georgia, n.d.

Diener, Stefan, et al. "Biological treatment of municipal organic waste using black soldier fly larvae." Waste and Biomass Valorization 2.4 (2011): 357-363.

Fuller, Janet Rausa. "Boom in Breweries Leads to Growing Problem: What to Do With Spent Grain?" DNAinfo. N.p., 20 Oct. 2014. Web.

Subasinghe, Rohana. "Aquaculture Topics and Activities: State of World Aquaculture." FAO: Fisheries and Aquaculture Department. FAO, 27 May 2005. Web.

Interviews

Zabel, Jeff. Water Utility Supervisor at the Ann Arbor Wastewater Treatment Facility. Personal Interview. 25 Nov 2016.

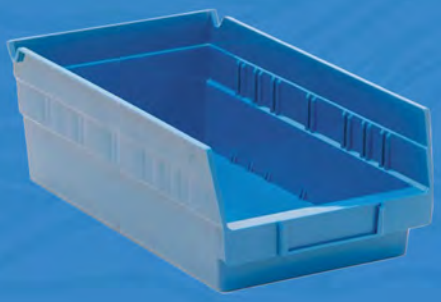
MATERIALS ANALYSIS

Repurposed Shipping Container

-easily available
-upcycled
-relatively cheap
-spacious
-can be retrofitted

-can be temp & humidity controlled
-movable
-stackable
-repurposed

-made from recycled plastic bottles
contributes to circular economy of recycling container products
-spacious, high volume capacity
-not subject to fluctuations in temperature (unlike metal)



Bins for Larvae

Spent Brewer's Grains

-principal input for system
-crux of our business; waste that no longer "goes to waste"
-nutrients captured and transformed
-acquired at no cost from partner breweries

-sourced from microbes that digest organic waste naturally
-self-repleneshing; reproduce and multiply with little to no maintenance
-harness biological power of natural processes

Microbial Community

All of these materials will be sourced locally, in Texas, where we are headquartered. We will install solar panels on the roof of the facility to offset high electricity costs for maintaining the interior of the container at 30°C. We are working with a Texas-based company with a strong environmental mission that retrofits shipping containers for other uses. The infrastructure of the refinery system is designed to be extremely long-lasting as it is made of durable materials. Our process doesn't produce any recurring waste products—even the insect excrement, known as frass, can be sold as a fertilizer.

ECONOMIC ANALYSIS

BSFL researchers

Other BSFL companies for collaboration

Food & beverage companies

Shipping container retrofitting company

Organic waste --> insect protein

Organic waste

Shipping container system

Consistent, reliable waste recycling & CSR boost for food & bev companies

Envt'lly sustainable, high-quality protein for feed millers

Partnership with food & bev comp

Direct bulk sales to feed millers

Close relationships with few companies

Trucking

Food & bev companies (initially: breweries)

Feed millers w/ organic/envt'l mission or product line

(eventually) Direct users, animal farmers

Direct sale of black soldier fly larvae to feed millers ($6,000/ton) and sale of frass ($300/ton)

S strengths

Our greatest strength lies in our innovation and scalability.

We can place our system on-site at many food & bev companies or organic waste producer.

We offer a brand-new usage for organic waste, adding more value than a composting system and offering a simpler and more cost-effective solution than an aerobic or anaerobic digester.

From an environmental point of view, we are closing an uclosed loop in our food system and replacing an unsustainable product with a sustainable one.

W weaknesses

One weakness is that we can't implement our system at companies in highly dense urban areas with extremely stringent space constraints.

Another weakness is that it will take some time to achieve economies of scale, because efficiencies depend on large amounts of BSFL data collected by our hardware sensors.

O opportunties

The opportunity is immense. We will first begin operating in the $100 million niche chicken feed market and the $288 million brewery waste management market and then expand to others.

Since we focus on intimate relationships with few, close customers (both food & bev companies and organic feed suppliers) we build trust and continuously collect detailed feedback.

T threats & risks

We risk hesitation in adoption because this is a brand new solution. We have finalized a deal with a brewery to built a first pilot facility to reduce this threat and serve as a proof of concept.

We risk a colony collapse because so little is known about BSFL biology that there are no tried-and-true practices in the field. To mitigate, we take a decentralized approach and maintain larvae in separate unit bins, isolating the threat.