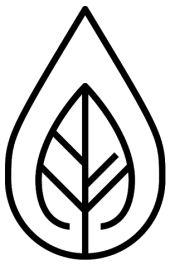

OXYPONICS

Summary Business Plan

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Executive Summary

OxyPonics is a novel solution whose goal is to increase the efficiency and efficacy of the aquaculture industry by autonomously monitoring and affecting oxidative stress in hydroponic systems. Our objective is to scientifically demonstrate to hydroponics farmers the value of oxidative stress monitoring as a more effectual additive to current sensors. We then plan to market this profitable solution directly to hydroponic farms. Our goals for this product are focused on efficiency and ease of installation. We aim to minimize the barrier of adoption in order to push forward the technological innovation this industry needs. Our efforts are trained on making available better tools for hydroponic farmers to improve their efficiency and yield.

Our core product consists of two main components: the engineered bacteria in dialysis tubing, and the electronic sensor component.

The hydroponics industry is young and growing rapidly. We hope to tap into these growth trends and introduce our product into the market as hydroponics establishments are rapidly developing and expanding. The hydroponics market is divided mostly between two technologies: deep water culture (DWC) and Nutrient Film Technique (NFT). Hydroponics is more geared towards DWC as it fits our product design better. DWC is a smaller market than NFT, but a proper demonstration DWC could lead into more widespread implementation of our product in NFT systems. Our main competitors in the market would be non-oxidative stress sensors/monitoring systems. Currently hydroponics farms use conductivity (nutrient concentration) and pH. We must demonstrate the added benefit of oxidative stress monitoring in addition to these traditional systems to enter the market. The hydroponics market is in need of innovations in efficiency and Oxyponics will be able to show and provide it.

Company Description

OxyPonics was conceived in the summer of 2017 by Cornell iGEM - a synthetic biology engineering project team composed of 30 undergraduate students. The premise of the project was to design a biosensor to efficiently and inexpensively detect and optimize oxidative stress in hydroponic systems in order to maximize agricultural output. We met

with local hydroponic farmers to discover more about the industry and its needs, as well as the adoption of hydroponic systems in agriculture. Utilizing this feedback, we created an oxidative stress monitoring system which couples fluorescent bacteria with a camera-rail system for imaging, to provide exactly the large-scale blanket-type sensing that conventional redox probes cannot. The success of the project and research motivates the company to implement our ideas in the real world as a business. Utilizing the research conducted by the team throughout 2017, OxyPonics created a novel biosensor that greatly enhances versatility and sensitivity over traditional systems. With the development of an effective large-scale sensing system to monitor plants and track data, the optimal level of oxidative stress can be determined for the plant systems. We hope to demonstrate the efficacy of our product and implement it in real hydroponic farms as a practical business.

Mission & Vision

We strongly believe that the agriculture industry is in dire need of innovation, which we aim to address by facilitating the optimization of oxidative stress. Our vision is to have OxyPonics sensor systems implemented in farms around the world, all of which would be used to collect data to better understand the optimal balance for different crops. Through this, we hope to meet a growing need for cheap, local food and accelerate one of the fastest growing, most cutting-edge industries in agriculture.

Products and Services

Hydroponics has been proven to have better time, water, and space efficiency than traditional soil techniques; however, there exists a common problem in this growing industry: hydroponic farmers face some of the lowest margins in agriculture. For example, farmers face high fixed costs due to energy costs, and also face the threat of disease on the farm. Cornell iGEM proposes the solution of controlling and monitoring oxidative stress, which is a chemical balance that exists in all living things. Research has shown that oxidative stress can affect crop growth and nutrient intake, and is the best predictor of future plant success.

The wet lab team has engineered bacteria that can detect oxidative stress and release light signals to communicate the level of stress. The platform uses redox-sensitive fluorescent proteins as a reporter to couple an external optics system to an intracellular

optogenetic transcriptional circuit. The ratiometric nature of redox-sensitive fluorescent proteins will signal an external receiver, which transmits this signal to an LED device to stimulate a downstream transcriptional response. The dual input from the reporter and the external LED greatly enhances both sensitivity and precision of the transcription. Furthermore, the genetic circuit encodes proteins that can catalyze reactive oxygen species to regulate the cellular oxidative stress. Therefore, this is a platform with both real-time reporting and stress treatment functionalities.

The Product Development Team created a monitoring system that couples fluorescent bacteria with a camera-rail system for imaging to provide large scale sensing and sends information to the farmer of the status of the plants. OxyPonics uses a three-part system: a fluorescent reporter, a rail based imaging system, and an online dashboard. The reporter protein will be contained in bacteria dialysis tubing (so as to not contaminate the system itself), and communicate data to the online dashboard via the sensing apparatus. The goal is to provide farmers with 24/7 access to updates and alerts regarding the status of their systems. In doing so, we hope to automate systems and to increase the rigor of plant growth.

In order to increase the oxidative stress of a system, farmers can choose from a number of different options, the best documented being bubbling ozone through the water. In order to decrease the stress in the system, however, options are more limited due to FDA regulations and the acute toxicity of many common reducing agents. Thus, OxyPonics integrates an automatic antioxidant response by way of light inducible expression of antioxidant proteins. Thus, we seek to mitigate the risk of overstressing the plants.

Current Status

Currently, the three-part system to OxyPonics has been successfully created. OxyPonics has not been sold to any farms as of now, but it will be marketed with a leasing/subscription model. Cornell iGEM will provide the sensors, the bacteria refills, and the installation and maintenance of the dashboard. In return, the clients will give a subscription fee every three months based on the amount of units they own.

Key Partnerships

OxyPonics will look to maintain strong partnerships with Cornell University and its faculty for their invaluable resources and expertise. We will also seek to partner with key players within the area of hydroponics and look forward to maintaining professional relationships with the hydroponics farms and experts that we contacted during our research process.

Industry Analysis

The hydroponic industry is large and rapidly growing. There are currently 2758 operations in a $23 million market producing $6-8 billion of produce annually [1]. The global market is expected to grow at a 6.7% compound annual growth rate [2]. The market is segmented in two ways: by method and crop. Most hydroponics farms use one of two technologies: deep water culture (DWC) and Nutrient Film Technique (NFT). DWC has a smaller share of the market but can benefit more from our system. These systems are essentially the same, but the physical structure of DWC will make it easier to install our system.

Industry Rivalry

The transition to hydroponic farming is often restricted by the traditional methods that still reign supreme. Hydroponic farmers rely on current sensor technologies which include pH and water conductivity (nutrient density). Although these current sensing technologies are sufficient for many establishments, we seek to demonstrate the benefit of adding oxidative stress monitoring.

Threat of Substitutes

As of now, there are no known substitutes for regulating oxidative stress. However, farmers may be more willing to pay for monitoring other important factors that affect plant growth, such as light, temperature, etc. Another substitute would be manually monitoring oxidative stress, instead of adding another cost into the farm.

Market Analysis

Market Segmentation and Demographics

Most hydroponics farms are divided into two categories: deep water culture (DWC) and Nutrient Film Technique (NFT). OxyPonics was engineered with DWC in mind, although expansion into NFT is certainly feasible and is a future goal. DWC is a stronger but smaller market for our product. There are no accurate figures on the size of the DWC market but hydroponics as a whole is a large market and a significant percentage of this should be DWC, which is our primary target.

The hydroponics market is also rapidly growing. According to Market Research Future, the global hydroponics crop value is anticipated to grow to $27.29 billion by 2022 at an estimated compound annual growth rate of 6.39% from 2015 to 2022 [3].These growth trends indicate a stronger market for our product since new establishments would be more likely to use our product as opposed to established farms.

While our product is geared more toward DWC, it is also applicable to the more widely used NFT. The market is also divided by crop. Current research shows that oxidative stress affects growth of greens including lettuce, but is ineffective against tomatoes.

Currently hydroponic farms do not use oxidative stress monitoring to optimize their system. Our research demonstrates that these farms can achieve a higher yield if they take advantage of our product and oxidative stress monitoring. Most farms monitor pH (acidity) and electric conductivity (nutrient concentration). This coupled with humidity and temperature control ensures proper environmental conditions. The gap is however with the uptake of nutrients. With this optimization plant cycles can be shortened allowing more harvests per year, increasing productivity and revenue.

Current Methods

Currently no farms use oxidative stress monitoring on a commercial level. We believe we can provide this and more importantly demonstrate the efficacy of monitoring oxidative stress. In identifying and addressing this niche parameter, we hope to be ahead of the competition and to be able to accurately and effectively monitor oxidative stress and optimize it for agricultural efficiency.

Competitors

We have competition in two forms: other types of non-oxidative systems and existing oxidative stress monitoring systems. There are other ways to measure oxidative stress such as biological probes [4]. However, these types of systems do not integrate well into hydroponic systems and are largely tailored to the needs of scientific labs but not agriculture. We will compete with the non-oxidative current methods by demonstrating the superior efficacy of our system as an additive.

Barriers to Entry

The main barrier to entry is the cost. Hydroponics systems are costly in themselves which means that any additional cost must be strongly justified. Hydroponics farmers will likely not be willing to take many risks.

One issue that most of the hydroponics farmers we talked to brought up was the lack of automated processes associated with hydroponics farms. Many of these farmers owned hydroponics systems which required manual attention to change rate or flow of nutrients and water. All of them expressed an interest in having more automated systems. Though some options currently exist they have been slow and difficult to integrate.

Economy of the Business

Hydroponics is a growing industry worldwide. According to the EPA, US hydroponic revenue has been estimated by IBIS to reach $607 million. Compared to total US crop production revenue, estimated by the EPA at $143 billion, this number may seem less significant. Despite that, the US hydroponic industry has grown at an annual rate of 3.6% in the last five years, faster than the growth the US GDP had experience in the same period [5]. This is not a trend exclusive to the United States, but one that is occurring worldwide. The largest hindrance to the hydroponics industry is the high labor cost involved. The Groucher College report, “Economic Assessment of Hydroponics Lettuce Production”, states that 90% of hydroponics production costs are comprised of energy (20%) and labor (70%) costs. This issue is one that OxyPonics seeks to resolve with an automated way to detect,

monitor and, when necessary, combat oxidative stress in hydroponic systems with a unique monitoring system that provides real time data to farmers in the industry.

Start-up Costs

Our start-up costs currently consist of the cost of patents and documentation, and all physical materials to construct the OxyPonics monitoring system, in addition to labor cost. The physical materials, including materials used in research and development, came to total of $689.00. The price of our product, however, is valued at $233.37. The table below lists our total costs for the duration of our research and development of the OxyPonics system.

CanaKit Raspberry Pi 3 with 2.5A Micro USB Power Supply	$42.99	1	$42.99
SanDisk 16GB Mobile MicroSDHC Class 4 Flash Memory Card With Adapter	$6.95	1	$6.95
ArduCam 5 MP Mini Camera OV5647 1080p for Raspberry Pi	$14.99	1	$14.99
900 mcd 470 nm LED	$0.40	10	$4.00
310 mcd 575 nm LED	$0.11	10	$1.07
Dialysis Tubing, 3/8 inch x 10 ft	$15.15	2	$30.30
iSeries 0702-1 Waterproof Utility Case	$14.27	1	$14.27
OG-590, 12.5mm Dia. Longpass Filter	$22.50	1	$22.50
Epoxy Adhesive, black, 37ML, 2-part	$20.03	1	$20.03
iSeries 0705-3 Waterproof Utility Case	$22.92	2	$45.84
ORP-2069 Digital Pen-type ORP Meter Redox Tester Tester Measure Water	$20.05	1	$20.05
Raspberry Pi 5MP Camera Module Webcam for Model Zero	$9.77	1	$9.77
Raspberry Pi Zero W	$10.00	1	$10.00
Ambient Light Sensor Breakout	$4.95	4	$19.80
450 SP Rapid Edge	$100.00	1	$100.00
Standard LEDs - SMD WL-SMRW RvsMnt Mono Dome 1206 BriGreen	$0.40	10	$3.99
LED Lighting Lenses Assemblies LUXEON REBEL SNGL LENS	$3.27	3	$9.81

HLDR			
Lens with Holder Clear 79°, 85°, 91° Wide Socket	$10.46	1	$10.46
580 nm Bandpass filter	$30.00	1	$30.00
470 nm Bandpass Filter	$25.00	1	$25.00
448 LED	$2.96	5	$15.00
Heat Shrink Tubing 3 inch 2:1	$4.60	5	$23.00
Roughneck Storage Box (18 gal) #2215	$12.39	4	$49.56
Arugula seeds	$2.95	3	$8.85
EASTMAN 1/2-in x 10-ft Rubber Fuel Hose	$6.99	3	$20.97
Submersible Water Pump	$11.90	3	$35.70
Nutrient Mix Maxigrow	$27.62	1	$27.62
PVC Adjustable Float Valve	$8.76	1	$8.76
1/2 inch Uniseal Pipe-to-Tank Seal	$1.45	16	$23.20
Rapid Rooter Replacement Club	$17.23	1	$17.23
Soil	$17.49	1	$17.49

Revenue Drivers

OxyPonics' main revenue driver is the sale of our monitoring sensor unit in addition to the sale of our monitoring sensor unit and fluorescent tagged bacteria. The sensor and the bacteria will be available for sale individually or one could purchase the system through a subscription model. There will be a one time base cost for the first use of the system, and at the time of purchase, the consumer will have the opportunity to register for a subscription plan. With this subscription model, the farmer will automatically receive bacteria refills, installation, and maintenance for the price of fifty dollars per every three months. This method is best suited for the product since, for continuous use, the bacteria will need to be replaced.

Marketing Plan

Marketing Strategy

OxyPonics is well-differentiated from other biosensors offered in the agricultural market. Its real-time detection and feedback mechanisms based on oxidative stress levels enable our product to have unparalleled specificity and to grant farmers high control over

plant health. Because plants grow optimally at very certain levels of exposure to reactive oxygen species, an automated feedback system to control these levels will draw farmers towards this product and essentially transform the industry.

We plan to market OxyPonics based on its many characteristics that make it unique and extremely useful for hydroponics farmers. No automated feedback oxidative stress sensors currently exist on the market, making OxyPonics revolutionary. Furthermore, we have developed a leasing plan that will prevent farmers from paying large upfront costs. Farmers have the option of registering for a subscription plan that includes bacteria refills, installation, and maintenance every three months for a price per unit of $50. Therefore, OxyPonics will attract extended-time users in addition to one time users. One-time users will be able to experiment with the system with minimal commitment, and long term users have a convenient subscription to receive extended service. Cornell iGEM is also working on transitioning our biological feedback system from E. coli to yeast. This is predicted to expand our market to people who oppose using live bacteria to treat their plants.

Product Distribution

Our product will consist of a monitoring sensor unit accompanied by fluorescently tagged bacteria that will report oxidative stress in a real-time manner. The sensor and the bacteria can be purchased individually, as a one-time investment, or as a subscription plan. The subscription plan will automatically ship new bacteria to hydroponics farms every three months and they will cost less compared to when bought individually.

Sales Process & Tactics

We will be selling our products directly to small and medium scale farms. Though OxyPonics was developed initially for DWC, we will be working heavily with our customers to provide a customized solution for each farm. Utilizing our farming network, we promote our product by visiting hydroponics farms and discussing with the farmers what our product is and how it can benefit them. We also publicize OxyPonics through emails, our website, phone calls, and interactions with our local community. We emphasize how our work can influence the industry of hydroponics and its efficiency, feasibility, and autonomous features. We promise to offer incentives to first time users in order to further encourage them to try our product.

Design and Development Plan

Development Status

OxyPonics is in the process of becoming a legal company. We are working toward getting a patent on our products and on making them mass marketable for our target consumers. When the company has officially started, Cornell University and the members of the Cornell iGEM project team will own it.

Intellectual Property

We are currently planning the process of obtaining patenting rights through Cornell University's Center for Technology Licensing. We hope to patent our oxidative stress monitoring sensor unit. We are also developing fluorescently tagged bacteria. These will be optimized and be confidential intellectual property.

Company Structure

The following list demonstrates the company structure OxyPonics will assume upon foundation:

- Board of Directors (including CEO, COO, CTO)
  - Finance
    - Manages taxes, capital and costs
  - Human Resources
    - Responsible for recruitment and payroll
  - Research and Development
    - Biology Division
      - Accountable for bacteria development and trials
    - Engineering Division
      - Perform product optimization and trials
  - Manufacturing
    - Biological Division
      - Large scale bacteria production
    - Detection and Monitoring Division
      - Large scale production of detection and monitoring systems
    - Packaging Division
      - Large scale production of product packaging
  - Information Technology
    - Includes modeling, software development, mobile app development, website maintenance
  - Marketing
    - Identify new markets, advertise products, community outreach, public relations)

References

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