



CYANO
TECHNOLOGIES **HEX**

Revitalizing
waterways and farmland
one island at a time

CyanoHex

Oxford Saïd Global

Climate Change Challenge

Zhi Han Yao | Emily Li | Blivia Zhang | Hailey Que Yap |
Christopher Louie



Problem Analysis

37%

As of today, **37%** of total water pollution in the Philippines is caused by fertilizer runoff.

1,000%

With a **1,000%** increase in (synthetic) fertilizer-use since the 1960s, eutrophication is expected to worsen.

Why is this Bad?

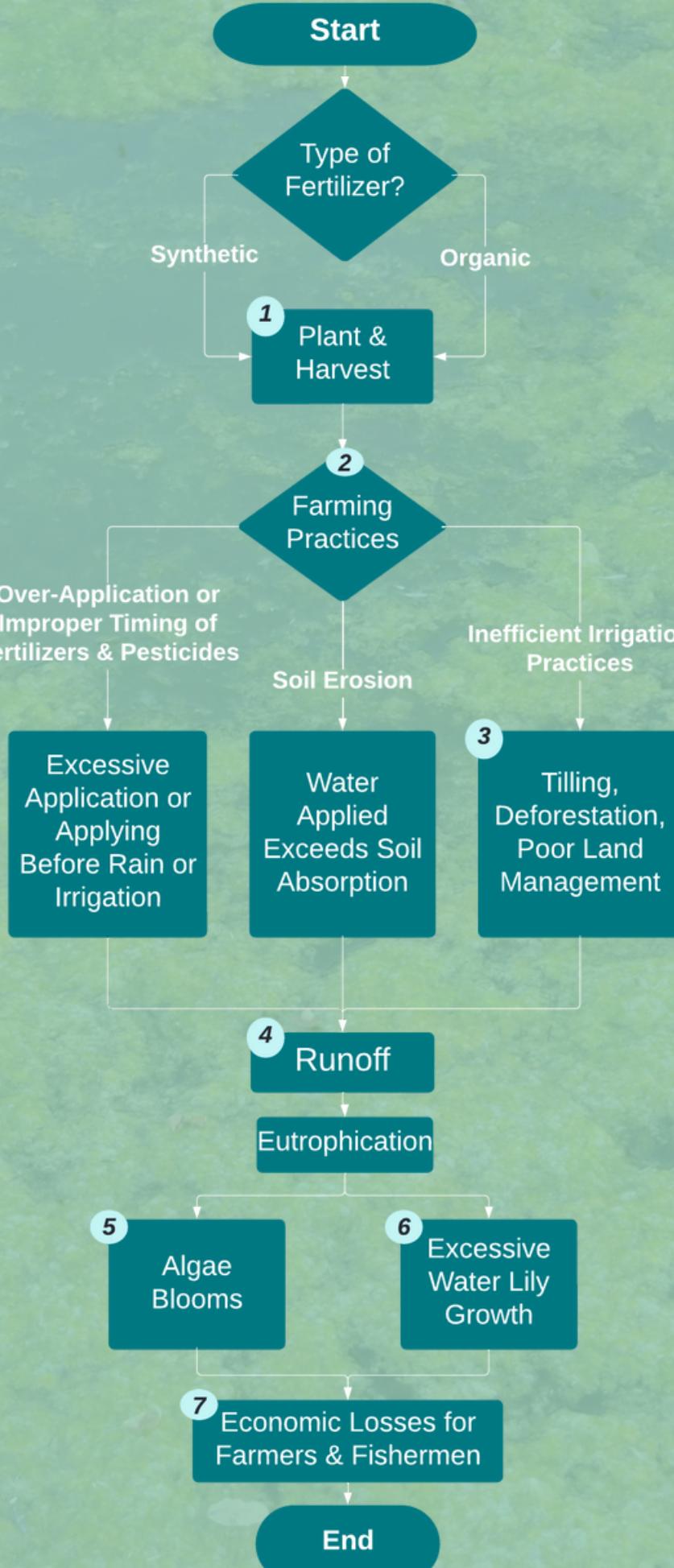
This massive increase in nutrients results in species of algae such as Cyanobacteria and plants like Water Hyacinths overcrowding their competitors.

- Algae proliferate rapidly (double in 24 hours), reducing oxygen levels and choking out marine flora & fauna.
- Water Hyacinths proliferate at a similar pace (doubling in 6 to 15 days), casting shade over waterways, resulting in the deaths of cornerstone marine flora.

As a Result

- **44 distinct locations** in the Philippines plagued by harmful algae blooms since 1983.
- **Over 20%** of Laguna de Bay's surface ruined by invasive water hyacinth coverage.

Current State of Philippine Agriculture & Fertilizer Usage



FERTILIZER USE & MANAGEMENT

- 1 Synthetic and organic fertilizers are applied 2-3 times per cropping season.

Organic Fertilizer

1. **Slow-release** (less nutrient runoff compared to synthetic): Promotes soil microbial activity, increasing soil fauna feeding activity by 35.2% to 42.5% and supporting nutrient cycling.
2. **Reduced Nitrous Oxide (N₂O) Emissions**: Mixing organic fertilizers with synthetic ones lowered N₂O emissions by about 18–27% compared to synthetic fertilizers alone.

Despite its benefits:

1. **Low-Adoption**: Local organic materials only supply ~0.49% of the nitrogen needed by Philippine farmlands. Uneven application leads to imbalanced nutrient release.
2. **High-Cost**: Over 70% of surveyed farmers cannot afford organic fertilizers (~300% more expensive than synthetic based on price per nutrient unit).

Synthetic Fertilizer

Immediate nutrient boosts. Degrades long-term soil quality by reducing organic matter content, pH, and microbial diversity.

ENVIRONMENTAL CONSEQUENCES

- 4 Excessive runoff of synthetic nitrogen and phosphorus fertilizers from agriculture accounts for approximately **37% of total water pollution**. Water is overly enriched with nutrients, especially phosphorus and nitrogen.

- 5 Harmful algae blooms (HABs) recorded in 44 distinct locations around the Philippine coast since 1983.
6 **>20%** of Laguna de Bay's surface is covered by invasive water hyacinth growth.

Results in:

1. **Oxygen Depletion & Biodiversity Loss**: Decomposition of algae & water lilies lead to hypoxic conditions that suffocate aquatic life.
2. **Water Quality Deterioration**: Produce toxins, foul odors, and discoloration, making water unsafe and unpleasant. This affects the **15 to 16 million people** that live around Laguna de Bay.

ECONOMIC CONSEQUENCES

- 7 Lower fish catches and slower growth in fish farming (cages and pens). Reduced availability and quality of water used for crop irrigation.

How CyanoHex Tackles Eutrophication

CyanoHex net is a processed organic fertilizer, engineered in the form of a honeycomb lattice woven from a tri-layer cord consisting of processed algae and Water Hyacinth.

Each layer of the cord as well as the woven shape serves an independent purpose meant to further reduce both chemical and physical runoff. It is expected to also increase crop yields by an additional 30-40%.



1: HARVESTING & REPURPOSING PESTS

CyanoHex targets nutrient-dense cyanobacteria as well as Water Hyacinths, both of which are a common result of Filipino freshwater blooms.

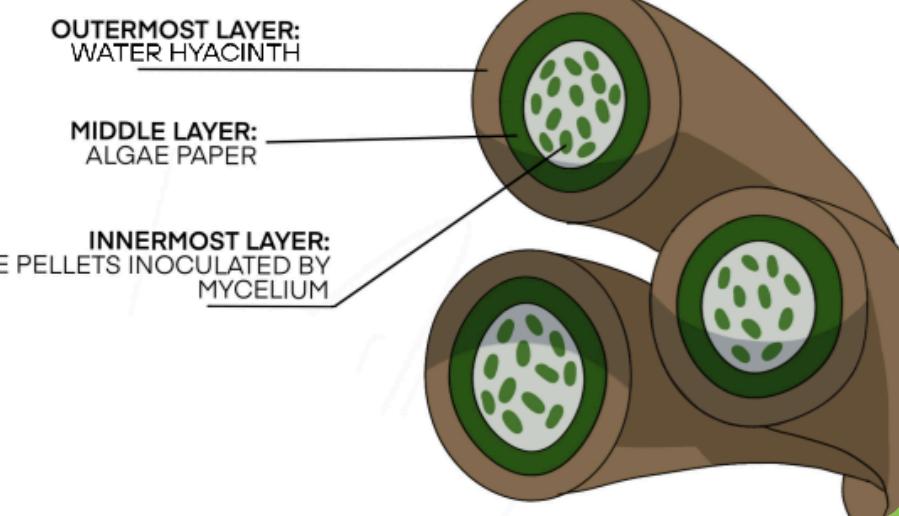
Results:

- Prevents the release of 70–80% of bound nitrates into the water.
- Stops toxic cyanotoxin release, methane emissions, and oxygen depletion leading to dead zones.
- Jobs created to support low-income rural communities, oftentimes the most heavily affected by eutrophication.

2: THE OUTER LAYER

Water hyacinths are naturally high in fiber content, perfect source for creating a dexterous outer shell to protect the internal components from the elements.

- Sun-dried to provide high tensile strength.
- Great source of potassium, calcium, and phosphorus for both the mycelium/crops.
- Glued together with dextrin starch, a form of water-soluble polysaccharide.
 - The mycelium encapsulated within is given enough time to properly develop/propagate as the soluble glue dissolves over time.



3: THE SECONDARY LAYER

The middle layer of CyanoHex is formed from algae-based paper made using sun-dried Cyanobacteria (Spirulina).

- Possesses cell walls with a naturally high surface area
- Rich with functional groups such as carboxyl, hydroxyl, and sulfonate
 - effectively adsorb nutrient ions, (NO_3^- , PO_4^{3-} , and Ca^{2+}) from the outer layer
- Aids in mycelium growth
- Serves as a secondary layer of protection.

Continued ...

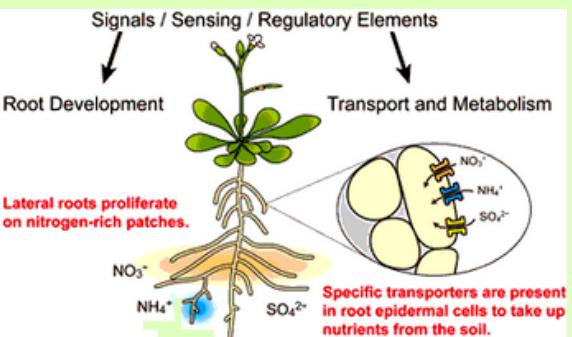


4: THE INNER LAYER

The CyanoHex lattice contains algae pellets formed from dried Spirulina (Cyanobacteria) machine pressed into small size pellets which are then inoculated with mycelium (arbuscular mycorrhizal fungi): *Glomus spp.* and *Rhizophagus irregularis*.)

As the mycelium develops a symbiotic relationship with nearby crops it will:

- fix atmospheric nitrogen into NH_3 (reducing the need of artificial fertilizer)
- solubilize bound phosphorus through organic acid secretion
- decompose organic matter into substances that increase the soil's cation exchange capacity.

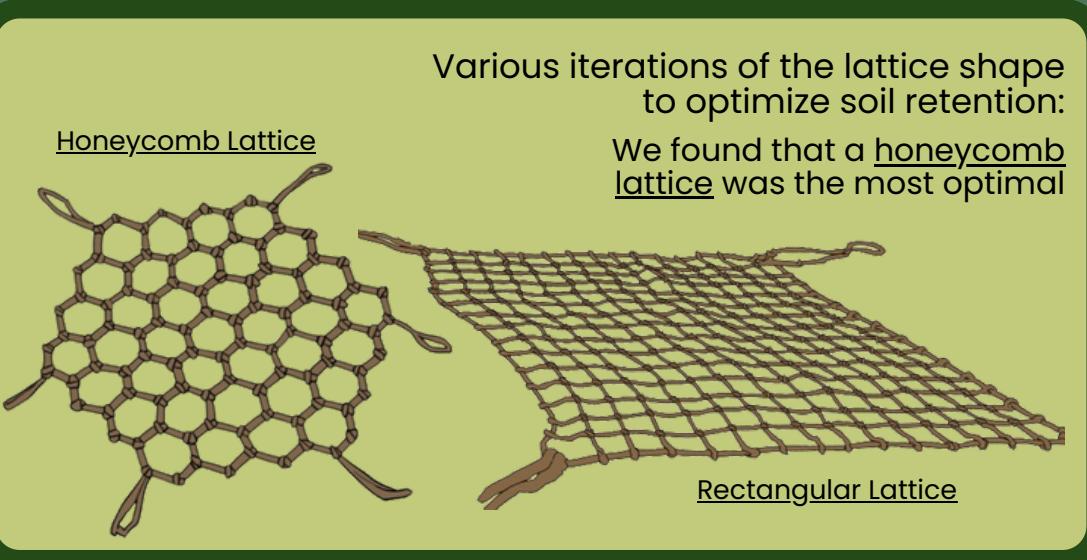


5: HEXAGONAL LATTICE

In order to maximize the surface of CyanoHex, we discovered that a honeycomb lattice was the most optimal for:

- Spread
- Soil retention
- Nutrient release
- Mycelium proliferation

All of these traits ensures that physical runoff is reduced by 40%-60%, Additionally, secreted mycelial compounds also physically entangles with soil particles at a microscopic level.



6: ELIMINATING EUTROPHICATION

All of CyanoHex's traits have been aligned with revolutionizing a more sustainable form of farming:

- fungal-plant symbiosis
- Nutrients recovered from algae and crop runoff are intercepted, and returned to the soil as NH_4^+ and PO_4^{3-} .

3-6 month biodegradation period: which conveniently crop cycles in the Philippines.

Re-introduced native mycelial networks ruined by centuries of outdated farming techniques.

Reduces the amount of fertilizer needed for higher crop yield.

THE APP (Front End/Back End)

Introducing the CyanoHex App: a method of engaging local communities with our mission while lowering company costs and providing jobs to local communities.

INTERACTIONS

Users interact with our platform in the following ways:

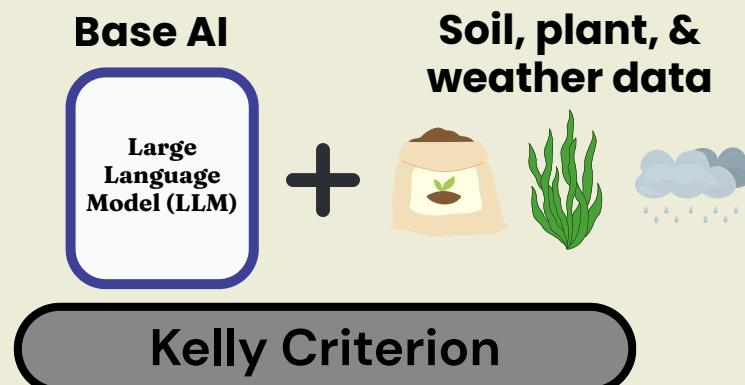
- Create Account/Login/Logout
- Searching for algae/hyacinth collection sites
- Delivering harvested algae/hyacinth to the CyanoHex HQ
- Collecting earned compensation for work

AI INTEGRATION

The CyanoHex app crowdsources agricultural/environmental data to fine-tuned a **Large Language Model (LLM)**. Then by determining the user's geographic proximity and weather conditions we personalized guidance based on back-tested local climate, soil, and crop data. Thus, users will be directed to harvest algae/invasive hyacinth in high priority areas.

THE ALGORITHM

- **Data input:** Farm locations, crop types, soil and climate info, harvest records, product usage patterns, hyacinth/algae measurements, etc.



Model Training (Kelly Criterion)

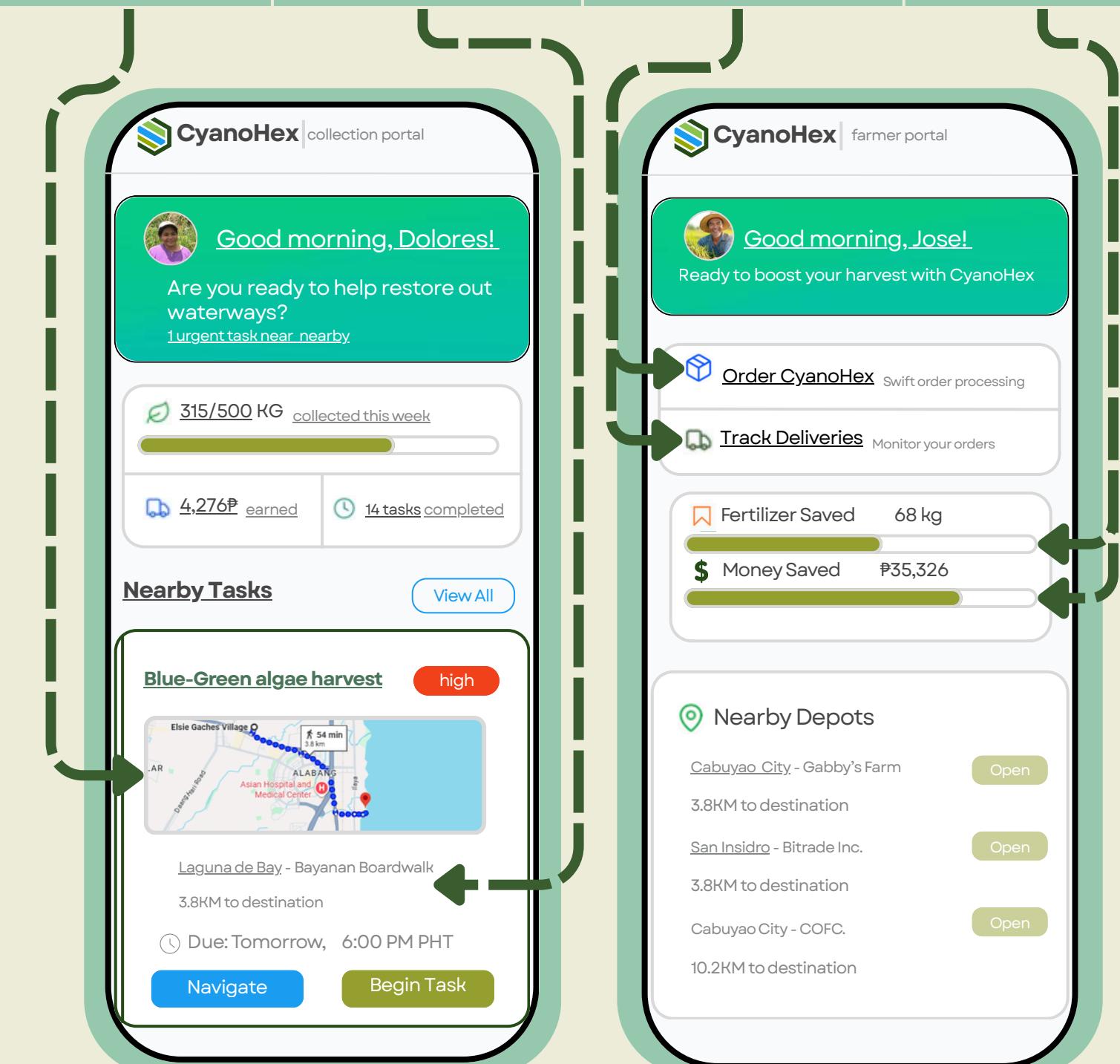
$$f^* = \frac{p}{l} - \frac{q}{g}$$

Trained
LLM

Our LLM, in its calculations on which locations are highest priority, will use the Kelly Criterion formula, which calculates optimal investments and sizes based on calculated risk/reward ratios.

Integrated User Interface/User Experience (UIUX) Features

Harvest Coordination	Dynamic Zone Management	Product Portfolio	Savings/Impact Metrics
GPS-mapped clean up sites and deposit sites .	Backend analytics to prioritize harvest areas and direct collectors efficiently	Browse CyanoHex products with stock visibility and pickup/delivery options	Tracks fertilizer replaced, weight used, and money saved



Partnerships

Stakeholders are grouped into distinct roles: sourcing, manufacturing, and distribution.

Kultibado, a startup founded by team member Hailey Q. Yap, works with 100+ farmers. Kultibado will connect CyanoHex to its agriculture network for partnerships.

SOURCING & MANUFACTURING: We leverage existing supply chains by partnering with NGOs/government entities that collect algae/water hyacinth through livelihood programs. Many need broader market access. Sourcing from them expands their revenue stream and improves local livelihoods.

DISTRIBUTION/TRAINING: The average Filipino farmer is 57 years old, leading to slower adoption rates for new agritech. Training is essential to help farmers effectively use CyanoHex.

	Proposed NGO/Government Partnerships	Partner Roles
Sourcing	<p>Villar's Foundation</p> <ul style="list-style-type: none"> Filipino NGO dedicated to sustainability and livelihood programs Facilitates waterway cleanups (water hyacinth removal) through the Sapig Illog Program <p>Department of Environment and Natural Resources (DENR)</p> <ul style="list-style-type: none"> Philippine government department: oversees the conservation, management, and proper use of natural resources Under the Philippine Clean Water Act (2004), the DENR monitors overall water quality (identifies harmful algae blooms). Partners with local fishermen to remove water hyacinths from waterways. <p>Philippine Textile Research Institute (PTRI)</p> <ul style="list-style-type: none"> A collaboration for R&D in the textile industry between the government and the private sector. Partners with the Villa Socorro Farm to train farmers how to extract fibers. 	<p>Source water lily fibers from:</p> <ul style="list-style-type: none"> Villar's Foundation: The Water Hyacinth Weaving Enterprise, a livelihood program where residents in Las Pinas collect water hyacinths. Regional DENR Offices: The Fisherfolk Harvest and Livelihood Project, which hosts training & direct clean-up operations. <p>Source algae from:</p> <ul style="list-style-type: none"> DENR: Though not an existing program, partner with the DENR to employ low-income residents to extract algae (livelihood project).
Manufacturing	<p>Machinery sourced by CyanoHex team (slide 8).</p> <p>Villar's Foundation</p> <ul style="list-style-type: none"> Runs livelihood programs focused on creating green jobs through sustainable enterprises that use local resources. Currently, residents are trained to make coconut coir nets. 	<p>Manufacture CyanoHex net:</p> <p>Collaborate with Villar's Foundation to recruit labor and oversee CyanoHex production, training residents to make water lily fiber nets using their existing skills. Provides additional income for agricultural or urban-poor communities.</p>
Distribution (Farmer Training)	<p>Agrea Foundation</p> <ul style="list-style-type: none"> Filipino NGO that engages with the entire agricultural chain and trains local farmers to promote sustainable agricultural practices. <p>Department of Agriculture (DA)</p> <ul style="list-style-type: none"> Philippine government department: promotes agricultural development by providing policy frameworks, public investments, and support services 	<p>Distribute CyanoHex and train farmers through:</p> <ul style="list-style-type: none"> Agrea Foundation's climate resilience series and agriculture workshops, where they teach farmers to use agritech. DENR's Agriculture Training Institute and its influence on nationwide infrastructure initiatives.

Eligible Grants for CyanoHex: Green Climate Fund and Asian Development Bank
(Fund projects supporting sustainability in the Philippines)

Implementation



Dried Fibers



Algae Washed in Lime/Chitosan Solution



Algae Cleanup Efforts



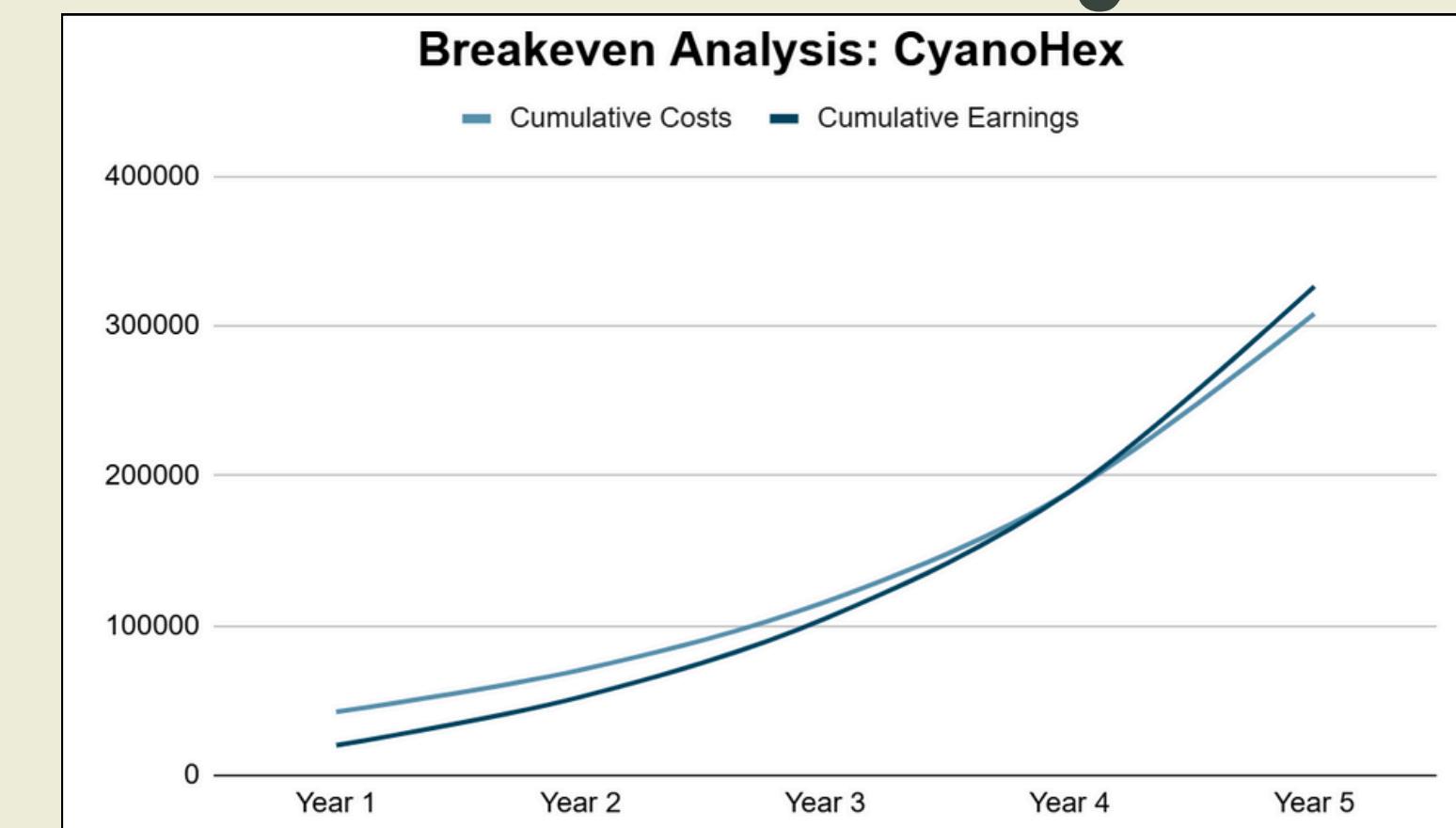
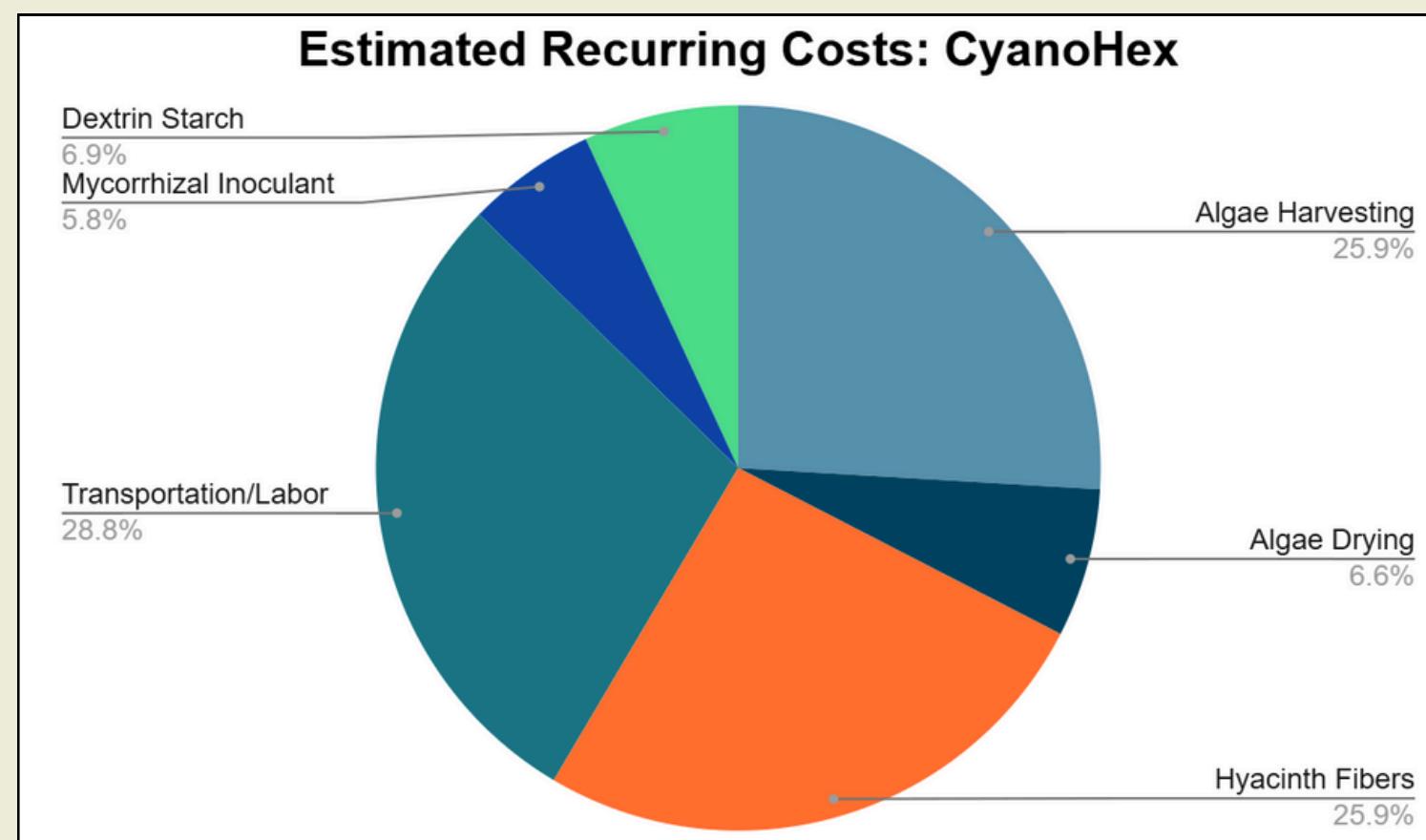
Philippines Department of Agriculture



Agrea Foundation

Sourcing	<p>Material Collection:</p> <ul style="list-style-type: none">• Community Mobilization: Algae/water hyacinths removal is conducted from waterways, creating jobs in partnership with nonprofits and gov. organizations (slide 6).• Digital Workflow & Payment: Collectors use the CyanoHex App for real-time updates on collection needs, depot location tracking, and instant wage disbursement via digital pay (GCash or PayMaya). <p>Material Processing:</p> <ul style="list-style-type: none">• Algae Treatment: Washed with a bath of lime and chitosan for the removal of impurities (heavy metals, pesticides, trash, etc). Algae is mixed with glycerin, then pressed & heated into dry sheets.<ol style="list-style-type: none">a. Portion A: Crushed and machine-pressed into pellets for inoculation (innermost layer).b. Portion B: Cut into rectangular sheets, serving as the algae paper layer (middle layer).• Water Lily Treatment: Rinsed and manually inspected for defects. Fibers stripped using fiber extractors. Sun-dried and used in the outer layer.
Production	<p>Building CyanoHex:</p> <ul style="list-style-type: none">• Innermost Layer: Tubs of algae pellets will be inoculated with either Glomus spp. or Rhizophagus irregularis. Left to grow in dark, damp conditions and continuously monitored for healthy growth.• Middle Layer: The rectangular strips are treated with UV light to kill unwanted growth. Then, inoculated algae pellets from the innermost layer are extruded. The algae strips are folded over & sealed with dextrin starch.• Outermost Layer: The dried Water Hyacinth fibers are soaked in dextrin starch and wrapped around the middle layer in a helical pattern.
Distribution (Farmer Training)	<p>Key Goal: Establish strong relationships with local farmers.</p> <p>CyanoHex App: Distribution of the CyanoHex net to farmers will be managed through the CyanoHex App in collaboration with the Department of Agriculture (DA) and the Agrea Foundation.</p> <p>Philippine Department of Agriculture (DA) & Agrea Partnership:</p> <ul style="list-style-type: none">• Partnering with organizations working directly with farmers will help foster positive relationships and trust within local communities.• A new module will be added to Agrea workshops & the DA's Agriculture Training Institute lessons to introduce and teach farmers how to use the CyanoHex net for effective fertilization and to mitigate eutrophication.

Cost Estimates & Breakeven Analysis



Our Initial Investment (\$25,000) includes machinery such as:

- Musa Agro Industries Hyacinth Fiber Cutting Machine - \$1,085
- Laizhou Kaihui Twisted Rope Machine - \$4,800
- Peletto GKM200 (Algae Pellet Machine) - \$3,100
- Algae Sun Drying Equipment - \$7,000



As for recurring costs (on a per-acre basis):

- Algae Harvesting - \$45 (300 kgs)
- Algae drying - \$11.5 (\$23/ton; 0.5 tons)
- Hyacinth fibers - \$45 (300 kgs)
- Transportation/Labor - \$50/acre
- Mycorrhizal inoculant - \$10/bag
- Dextrin Starch - \$12 (20 kgs)
- Lime/Chitosan mixture - \$10 (20kgs)

** Prices are calculated from commercial orders for the creation of 40 acres of CyanoHex.

Gross Total Cost: \$173.5/acre

With a \$43,000 grant/subsidy total from organizations such as the Green Climate Fund and local governments, we can lower the costs for locals to **\$100 per acre** for the first 423 acres (breakeven point).

To recoup our initial investment, we expect our break-even to occur at around \$189,000 in revenue.

- This would be achieved at around **Year 4** with current sales models ($100 * 1.618^n$ acres/year n).

Year-by-Year Analysis		
Year	Cost	Revenue
1	\$17,350	\$20,000
2	\$28,072	\$32,360
3	\$45,421	\$52,358
4	\$73,491	\$84,716

Market Analysis

Defining the Market

Nutrient pollution resulting in algal blooms has widespread negative effects on society, totaling billions spent in cleaning polluted water bodies, treating polluted drinking water, and costing billions in lost tourism activity, fishing production, and infrastructure damage. This is a direct result of harmful algal blooms. Removing HABs is also expensive: from 2010 to 2020, communities spent over \$1 billion combating algal blooms.

Thus, we conclude the market size at the moment is over \$1 billion, making the industry very profitable if a solution can be found to HABs and eutrophication. With a 0.1% market share, we will already have generated \$1,000,000 in revenue. We plan to achieve this by Year 3.

Competitor Analysis

Competitor	Solution	Cost/Status	Limitations	Total Revenue
Neisser Geo (NeiG)	Coir and Jute Erosion Control Geotextiles	Not specified (Still Developing)	Durability dependent on material; metal component may alter biodegradability profile	Undisclosed
LG Sonic	Ultrasonic Algae Control (MPC Buoy + Monitoring Buoy)	Commercial deployment available >\$100,000/unit	Efficacy varies with species and conditions; tech complexity	Undisclosed
Industrial Phycology	Algae extract nutrients (P, N, CO ₂); biomass harvested as slow-release fertilizer; no chemicals added.	Emerging commercial solution Expensive	Requires controlled algae cultivation and harvesting infrastructure	Undisclosed

Market Evaluation

CyanoHex stands out as an integrated, community-driven solution, combining:

- Algae nutrient capture (like I-Phyc)
- Biodegradable structural mesh (unlike clay or ultrasonic-only systems such as LG Sonic or Neisser Geo)
- And livelihood creation via low-income sourcing and production (versus industrial or chemical methods).

The market addressing eutrophication is largely still developing, and consequently our current competition isn't much of an issue.

Scalability

Besides the Philippines, other developing countries struggle with synthetic fertilizer runoff, eutrophication, and the resulting overgrowth of water hyacinth/algae. We've composed a chart of four countries CyanoHex can expand to: Indonesia, Cambodia, Laos, and India.

	<u>Indonesia</u>	<u>Cambodia</u>	<u>Laos</u>	<u>India</u>
<u>Sourcing</u>	CLEAN RIVERS <ul style="list-style-type: none"> Project STOP & Clean Rivers, a waste management system for rivers. While algae cleanup is not their focus, volunteers can be trained. Source water hyacinths from bodies of water with significant overgrowth from eutrophication, such as Sidoarjo in East Java. 	 <ul style="list-style-type: none"> A social enterprise that teaches villagers to harvest and make handicrafts from water hyacinths. Marine Conservation Cambodia, an NGO that restores marine ecosystems, provides zoning reports on HABs. Partner to harvest algae. 	<ul style="list-style-type: none"> Water hyacinths and algae are harvested locally as a food source. Employ villagers near bodies of water to source water hyacinths and algae. Ex. Mekong River 	 <ul style="list-style-type: none"> Clear Robotics, a private company that mechanically removes water hyacinths (collects one ton per day). Hire locals near bodies of water struggling with eutrophication to collect algae, e.g., the Ganges River (safety must be considered).
<u>Manufacturing</u>	Machinery sourced by CyanoHex (slide 8). Labor sourced locally through partnerships with community livelihood programs.			
<u>Distribution (Farmer Training)</u>	 <ul style="list-style-type: none"> Non-profit directly working with farmers to test agritech; provides online/in-person courses for sustainable farming. 	 <ul style="list-style-type: none"> Jesuit Mission, an NGO working with the Karina Battambang Organization to teach rural farmers about sustainable practices. Distributes green tech. 	 <ul style="list-style-type: none"> NGO that distributes green tech to farmers. Uses a participatory approach to teach sustainable agricultural practices. 	 <ul style="list-style-type: none"> NGO; Runs the Agriculture Development Program and works with small farmers to teach new & sustainable agricultural practices/tech.

Meet the Team



Hailey Que Yap



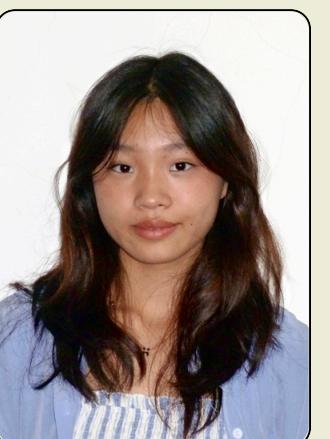
Boya (Blivia) Zhang



Zhi Han (Anthony) Yao



Christopher Louie



Emily Li