Feed The World With Algae

The Harvesting Breakthrough That Makes It Possible

Breakthrough water cleanup technology for oil & gas, algae and other water-intensive industries
Animal Feed Shortages

- Ethanol mandate now using 40% of US corn.
- **Livestock** farmers face mounting losses as feed costs rise - [Reuters](#)
  - Feed accounts for 60 — 70% of the costs for animal production.
- Heat and water stress could reduce yields by 25% in the 2030 to 2049 period.
Feed Vs. Food

• Corn and soybean prices up over 300% in seven years.
• US Beef Prices up 8% Year on Year.
• Droughts currently depressing farming in:
  – US, China, Mongolia, and Africa.
  – Further droughts expected.
Feed Prices Take Off

Average Farm Prices per Calendar Year

Bushel Price


Corn

Soy
World population 9B by 2050

• Quality of life rapidly improving in developing countries.  
  – China, India, SE Asia, Africa
• Demand for animal products rising fast.
• Depletion of wild fisheries driving a boom in fish and shrimp farming.
• Fish farming surpassed beef production in 2010 and rising 10 times faster.
The Feed Shortage

HOW ALGAE CAN HELP
The Promise of Algae

• Algae is...
  ✓ More nutritious than grain.
  ✓ Blends up to 60% in animal feed*.  
  ✓ Omega3 source for healthy fats.

• Compared to land crops, algae uses...
  ✓ 3% of the land.
  ✓ 2% of the water.

And... algae as feed doesn't compete with food for humans!

* Source: Texas A&M
Algae Is More Nutritious

- Algae is a higher quality feed than soybean; and it is not normally GMO.

<table>
<thead>
<tr>
<th>Soy vs. Algae</th>
<th>Soy</th>
<th>Algae*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>44%</td>
<td>55%</td>
</tr>
<tr>
<td>Lipids</td>
<td>2%</td>
<td>18%</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>39%</td>
<td>15%</td>
</tr>
<tr>
<td>Ash</td>
<td>15%</td>
<td>12%</td>
</tr>
</tbody>
</table>

* Chlorella Vulgaris
Algae can solve the world’s feed problem!

But...

• Algae lives in a lot of water – up to 1000:1
• Harvesting this low density algae is cost-prohibitive.

Therefore...

The algae industry must grow dense algae — which is not sustainable.
Why Unsustainable?

• If autotrophic (Grown by Light)
  – Shadowing rapidly slows growth.
  – Predators erode nutritional value.
  – Bacterial invasions lead to crashes.

• If heterotrophic (Grown in the Dark)
  – Relies on sugars, a human food commodity.*
  – High cost and energy consumption.
  – This is not the breakthrough we’re looking for!

* Sugar waste (bagasse) is geo-specific and limited.
OriginOil Harvesting

- Enables commercial algae harvesting:
  - Enables *daily harvest* of low density Algae*.
  - Continuously delivers whole, live algae concentrate.
  - Bacteria free, extends shelf life from hours to days or even weeks.
  - Low energy cost: ~US$50 per ton of algae concentrate (at $0.10/KwH).

*Continuous algae growing is now viable in open ponds and PBRs!*

* 0.3 to 1 g/L
Video: EWS Algae Harvester

Press the symbol to Play. Right click for Full Screen.
If no response, click here to Play.
OriginOil Harvesting Benefits

• 100% CHEMICAL-FREE.
• Continuous recycling of sanitized water keeps predator and bacteria levels low.
• Low-density: shadowing isn’t an issue.
• Daily turnover: crash risk greatly reduced.
• Clean concentrate, easy to dry or mix.
• Stable and predictable production costs.
OriginOil Harvesting

End Product:
An intact, clean, nutrient-rich algae concentrate with extended shelf life, ready for blending.
OriginOil-Harvested Paste
OriginOil’s Breakthrough Harvesting Process

ELECTRO WATER SEPARATION (EWS)
How It Works: Stage One

Single-Step Extraction (SSE) reactor tubes neutralize algae cells’ electrical charge so they clump together (flocculate) with minimal damage to algae cell walls.
How It Works: Stage Two

Electrically-generated clouds of micro-bubbles force algae ‘floc’ to the surface, to be continuously raked off as intact, bacteria-free concentrate with extended shelf life.

Stage Two: Flotation

Formation of micro bubbles by electrolysis

Titanium Alloy Anodes

Stainless Steel Cathodes

Micro bubbles attach to algae clumps and lift them to the top of the water body

Algae concentrate is raked out of the chamber
The EWS Algae Harvester

• Skid-mounted or trailered for rapid deployment.
  ✓ Drying and pelletizing attachment available.

• Models are rated in Liters/minute.

EWS Algae Model 120 shown
## EWS Algae Is Superior

### Algae Dewatering Process

<table>
<thead>
<tr>
<th>Feature</th>
<th>Membrane</th>
<th>Centrifuge</th>
<th>Chemical</th>
<th>Mechanical</th>
<th>Electro Water Separation™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical-Free</td>
<td>✔️</td>
<td>✔️</td>
<td>✗</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Low Energy</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>Continuous Process</td>
<td>✔️</td>
<td>✗</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Low Cost</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>Bacteria Removal</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✔️</td>
</tr>
</tbody>
</table>

Feed The World With Algae © 2014 OriginOil - Patents Pending
RESEARCH AND SHOWCASE SITES
Algae Feed Research Site

• Catalina Sea Ranch: First US deepwater shellfish program.

• OriginOil will:
  – Provide EWS Algae Model 12 to:
    ✓ Treat incoming seawater
    ✓ Harvest algae to feed shellfish nursery
  – Get access to nursery for field research.

Global mussel production: ~2 million metric tons
Over $1 billion annually
Showcase Sites

- National Algae Association: made OriginOil’s algae harvester part of its permanent algae demonstration site in Houston, Texas.
- Ennesys: French joint venture focused on algae production to meet European Union’s energy and waste regulations for buildings.
- Aqua Farming Tech: OriginOil technology in use to sanitize 120 acres of ponds and produce algae for fish feed.
Commercial Strategy

1. Work with end-users to prove scale
2. Work with institutions to develop new applications
3. License non-exclusive OEMs worldwide to integrate our technology into offerings...
   - Feed suppliers
   - Equipment vendors
   - Integrated algae producers
   - What’s your business model? Talk to us!
OriginOil’s Algae Team

- Research: Nicholas Eckelberry
- Engineering: Lee Portillo
- Product Management: Dave Anderson
- Commercialization: Jean-Louis Kindler
- Sales Support: Devin Angus

MORE INFO AT ORIGINOIL.COM/ABOUT-US
For More Information

• Call:
  US:  (877) 939-6645    Ext. 5
  Int’l: +001-323-939-6645   Ext. 5

• Email: sales@originoil.com

• Meet us at shows:
  European Algae Biomass 2014 — Seville, Spain
  Algae Biomass Summit 2014 — San Diego, CA