An elite variety of algae

For very low cost farming
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- BSc - Biochemistry and Molecular Biology. First Class Honours. *The University of Melbourne*.
- BSc (Hons) - Genetics and Physiology of Microalgae. First Class Honours. *The Australian National University*.
- PhD (Eng) - The Domestication of Microalgae through Selective Breeding. Submission imminent. *The University of Melbourne*.

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The challenge for economical algae production

My solution: Start with a species of algae that has a superior capacity for domestication. Make large and rapid biological improvements (very possible).

Aquatic Species Program – An 18 year study of algae farming

1. “there is little prospect for any alternatives to the open pond designs”
2. “the factors that most influence cost are biological, and not engineering-related”

The industry standard solution: Bioprospect for wild species of algae that have the best characteristics. Make any biological improvements (if possible).

Wild Wheat

Domesticated Wheat

My solution: Start with a species of algae that has a superior capacity for domestication. Make large and rapid biological improvements (very possible).
Domestication of Chlamydomonas reinhardtii (Chlamy)

**Chlamy a model organism**
Over 70 years of accumulated research

**Sexual characteristics enabling domestication:**
- Up to 100% mating efficiency
- Up to 100% germination efficiency
- Under 1 week zygospore dormancy
- Reliability & reproducibility
- Proven meiosis
- Protoplast fusion & somatic hybridization
- Generation of polyploids

**Other characteristics enabling domestication:**
- Knowledge = complex selection experiments
- A host of genetic tools for metabolic engineering
The breeding program (methods and output)


**Mutagenesis:**

**Selection (GS):**

**Sexual recombination:**
The key characteristics of an elite variety of algae

- **Salt tolerance**
  - Scalability
  - Contamination control
- **Self-aggregation**
  - Cheap harvesting
  - Contamination control
- **Sexual reproduction**
  - Adaptation / productivity
  - Biological improvement
  - Contamination control
- **Mixotrophy**
  - Increased productivity
  - Use of organic wastes
  - Contamination control
- **High starch content**
  - Best producer known
  - Bioethanol
  - Biodiesel & biohydrogen
- **Easy processing**
  - Cost effective digestion
  - No mechanical disruption

And more...
Lowering the farming cost with an elite variety of algae

Culturing:
Three main culture strategies relate to its holding vessel.

Enclosed Photobioreactors (PBRs):
- Very expensive
- High productivity
- Great control
- High-value products / Inoculum

High rate algal ponds (HRAPs):
- Cheaper than PBRs
- Moderate productivity
- Industry standard for feeds & fuels
- Economics not achieved
- Inoculum

Very large unmixed ponds (VLUPs):
- By far the most cost-effective
- Highly scalable
- Contamination control required
- Can be used with an elite variety of algae!
Economical production using an elite variety of algae

**Farm production:**
- **Farm size:** 1,200 Hectares (3,000 Acres)
- **Algae production:** 6,000 tonne per year
- **Biosolids, Biogas electricity & Wastewater treatment**

**Market information:**
- **Target markets:** Shrimp producers
- **Market size:** $6 billion and growing
- **Location:** Huge Asian markets nearby

**These are natural algae feeders**

**Financial estimates:**

<table>
<thead>
<tr>
<th>Initial Capital Cost</th>
<th>$39,329,462</th>
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<tbody>
<tr>
<td>Revenues (Total)</td>
<td>$18,444,414</td>
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<tr>
<td>Dried algae powder</td>
<td>$4,866,667</td>
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<tr>
<td>Live algae produce</td>
<td>$3,650,000</td>
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<tr>
<td>Biosolids</td>
<td>$3,954,167</td>
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<td>Biogas electricity</td>
<td>$3,765,331</td>
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<tr>
<td>Wastewater treatment</td>
<td>$2,208,250</td>
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<td>Costs (Total)</td>
<td>$14,789,595</td>
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<td>Capital Maintenance</td>
<td>$3,493,946</td>
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<tr>
<td>Capital Depreciation</td>
<td>$3,354,946</td>
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<tr>
<td>Operations (less labor costs)</td>
<td>$551,329</td>
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<td>Human resources</td>
<td>$5,304,373</td>
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<tr>
<td>Overheads (includes R&amp;D costs, less labor costs)</td>
<td>$2,085,000</td>
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<td>Profit</td>
<td>$3,654,819</td>
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</tbody>
</table>
Thank you!

@TheAlgaeBreeder