From Obstacle to Opportunity: Valorisation of algae produced in African fish ponds

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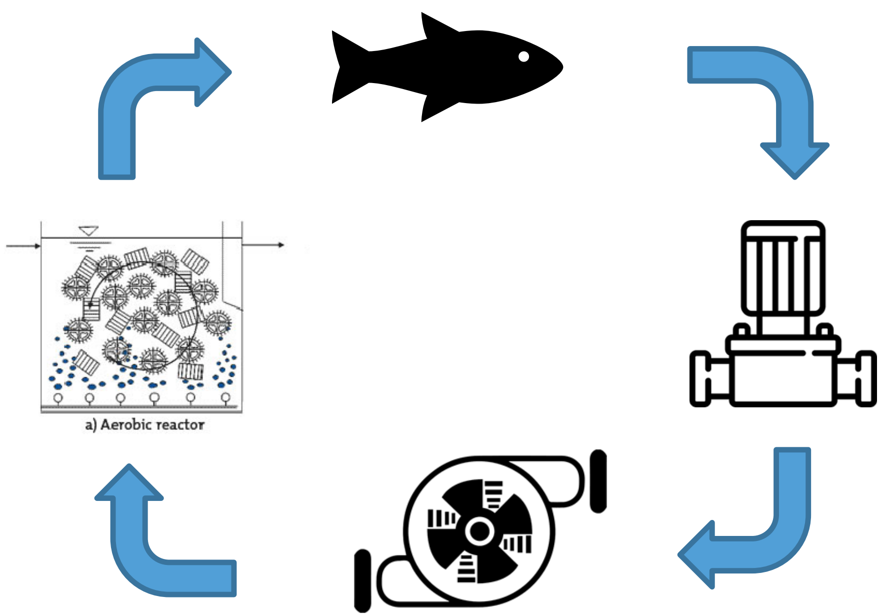
RAS (Recirculating Aquaculture Technology)



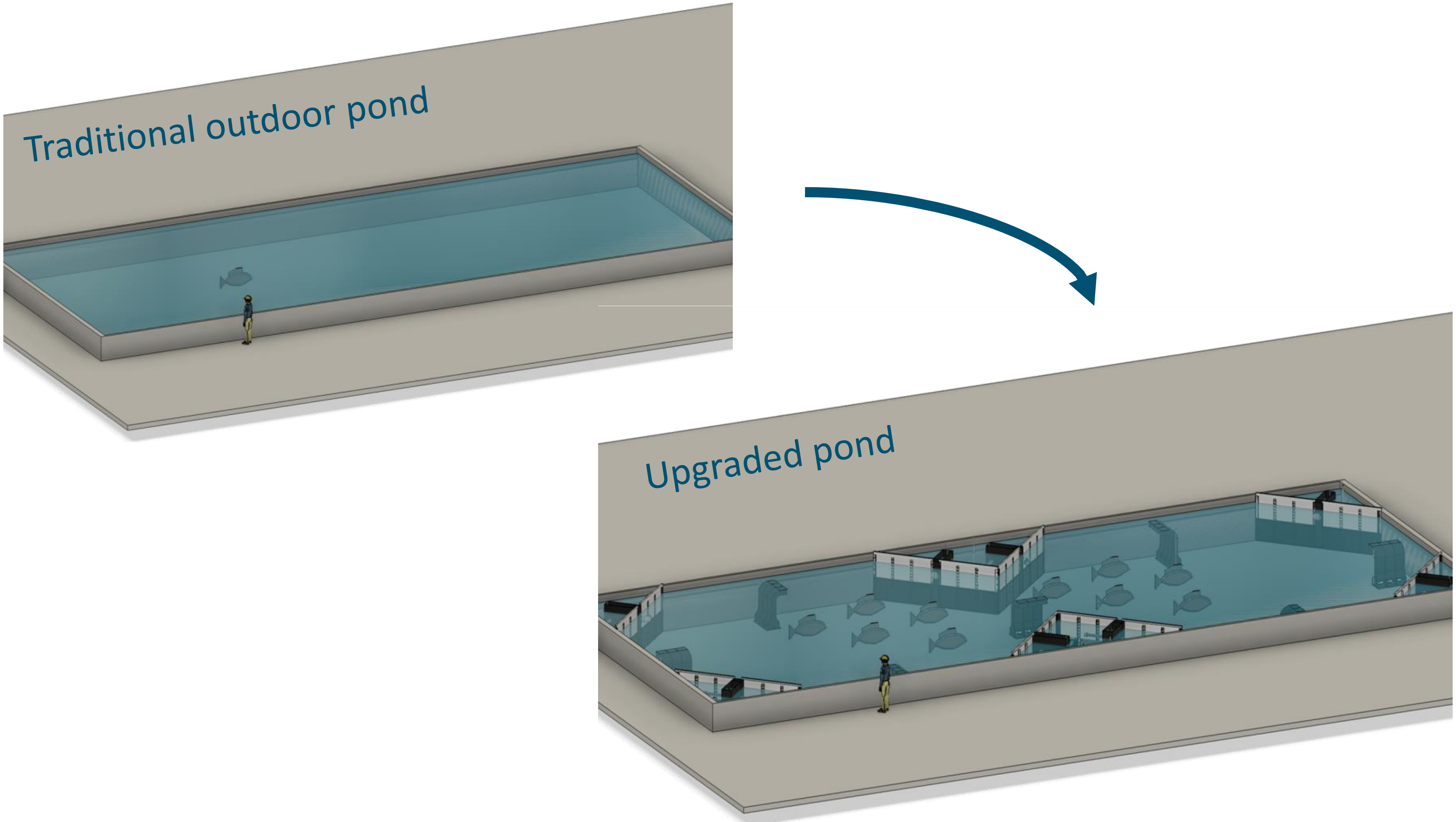
Disadvantages

- High investment
- More complex

Advantages

- Control
- Water reuse
- Low footprint
- Sustainable

Aquaculture development

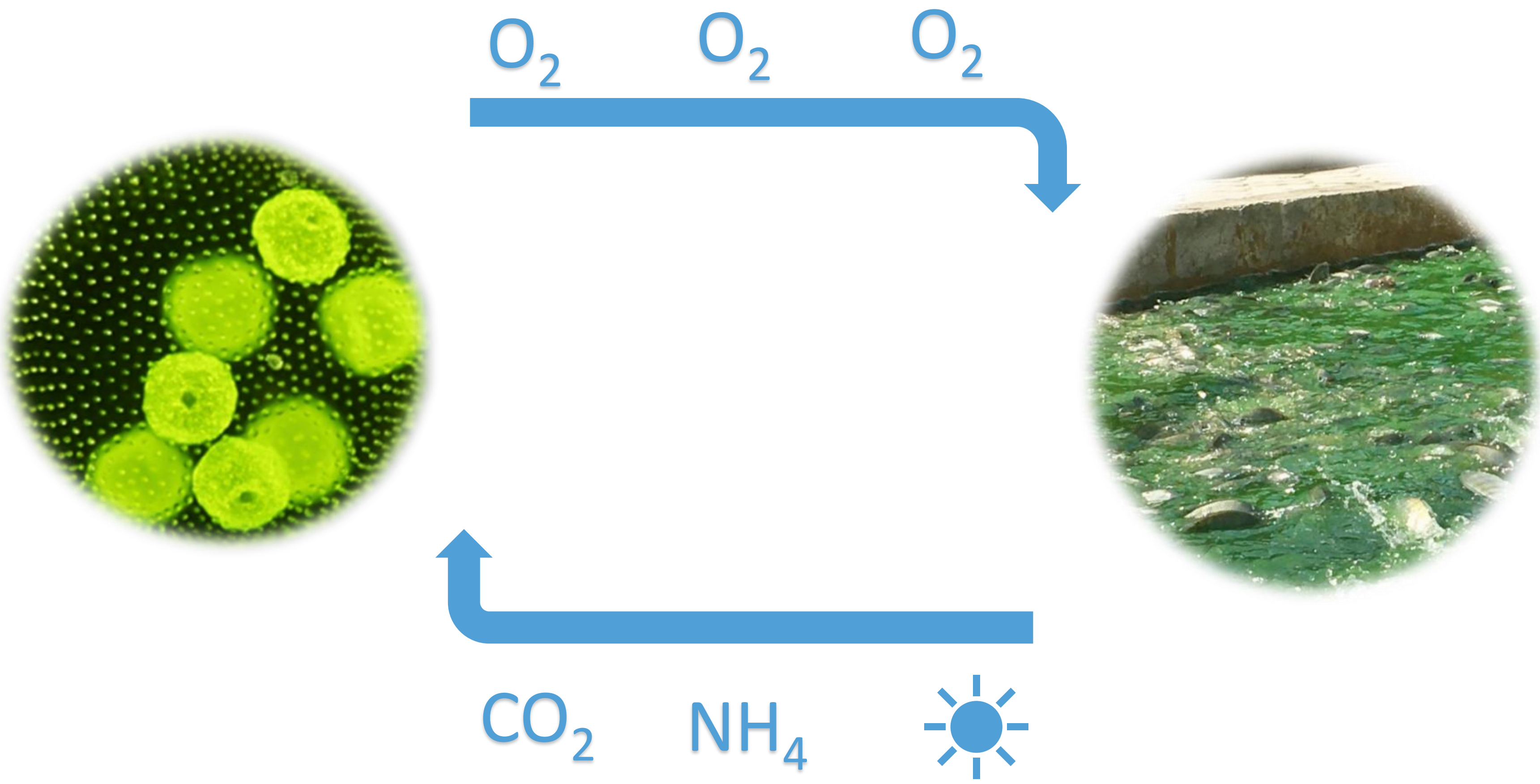


Examples

Bigfish, Tanzania

Tulungagun, Indonesia

Concept: Symbyotic Aquaculture Production



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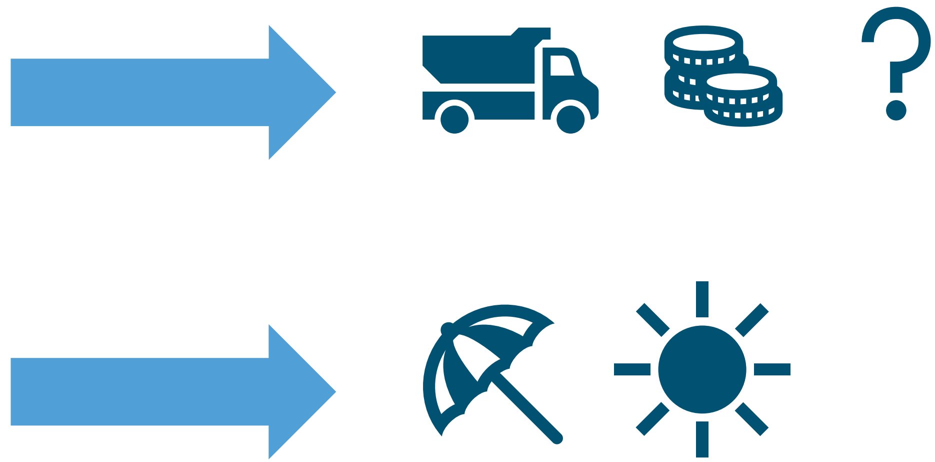
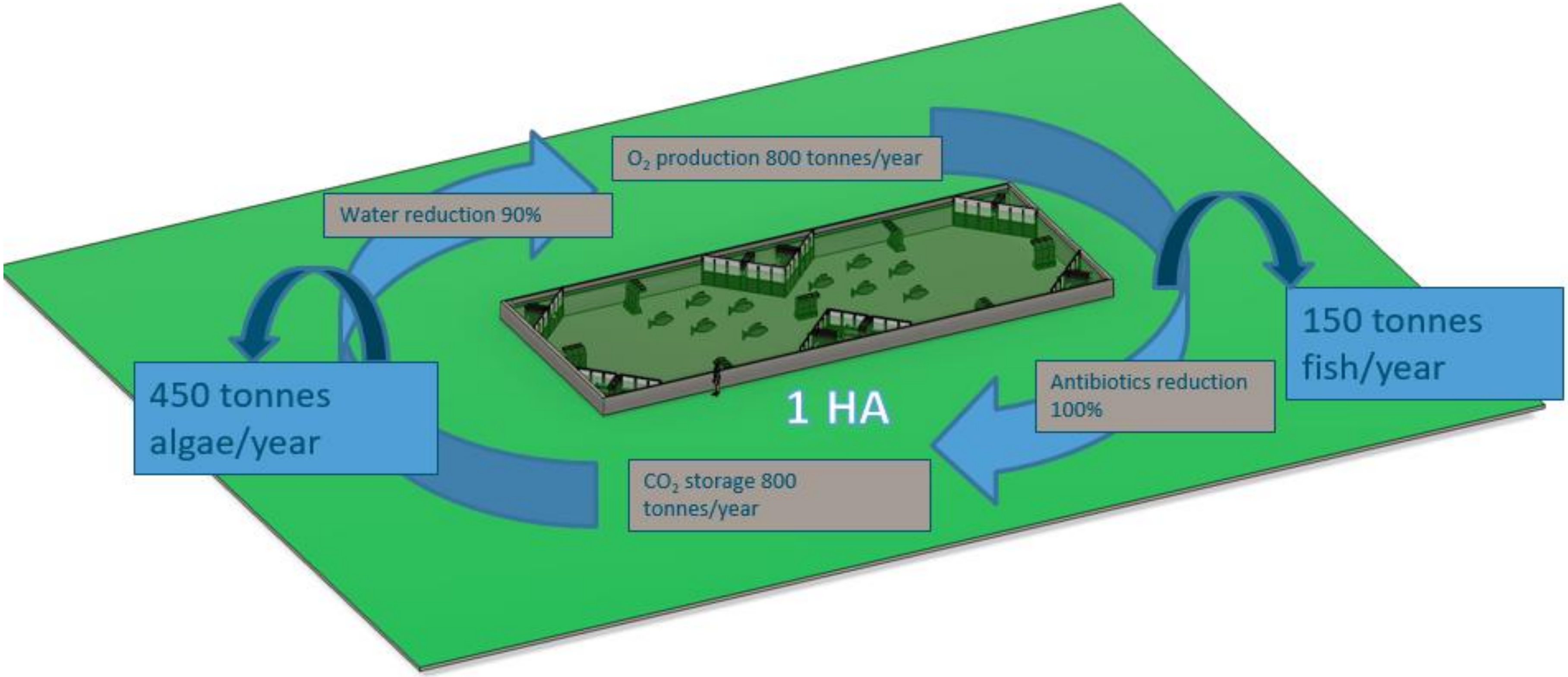
Strategy Algae Growth Control



Quantitative analysis



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Main question: feasibility of business case

- Value algae (composition)
- Production volume
- Processing costs
- Market demand and potential

Meet the team

Sander van den Burg, WUR

Rebekah Simmons, WUR

Victor Bierbooms, Viqon

Menno Morenc, Larive

Florine Kremer, Larive

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Method

Phase	Activity
1. Assessment of current algae production on a pilot farm	Field research in Tanzania
2a. Assessment of potential applications	○ Interviews with experts and professionals ○ Literature review
2b. Analysis of production costs and technologies	
3. Possibilities of a follow-up	

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1. Assessment of current algae production

Several species together

Contamination with waste

3x more production

No production costs

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2. Potential applications

What can we do within the current situation?

What could we do to optimize the current situation?

2. What can we do within the current situation?

	Quality and regulatory requirements	Volume requirements	Processing requirements	Financial compensation
Animal feed				
Fertilizer				
Additive to animal feed				
Biofuel				
Cosmetics				
Human consumption				

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2. What can we do within the current situation: Animal feed

Advantages

- Protein levels
- Minimal processing
- Regional sales market
- Sustainable protein source

Points of attention

- Sterility
- Toxicity
- Consistency of quality

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2. What could we do to optimize the current situation?

Stimulate growth of certain species

Overcome current quality challenges

Create synergies with fish farming

Summary

What can we do?

Local animal feed in bulk

- The best option for the current situation

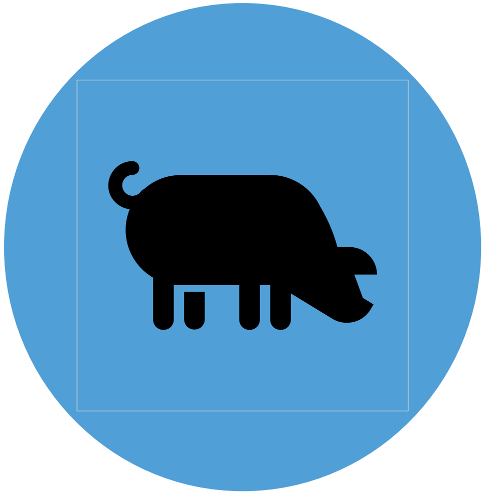
What could we do?

Research options for high-end application

- Optimization of the current situation

Follow-up research

WP1: Detailed understanding of the current situation



WP2: Small-scale trials to produce animal feed

WP3: Economic feasibility study

WP1: Detailed understanding of the current situation

- Research question: To what extent do the characteristics of the micro-algae change over time? E.g. in terms of...
  - Protein levels
  - Toxicity levels
  - Different species
  - Quality
  - Volumes
- Research design: Multiple measurements in Big Fish pond over a longer period of time (February to April)

WP2: Small-scale trials to produce animal feed

- Research question: How can we turn the micro-algae into animal feed that meets the necessary requirements at a low cost?
- Research design: Small-scale trials at Big Fish (possibly extent the number of ponds)
  - Testing how volume and quality requirements can be met most efficiently
  - Testing different processing methods (sterilizing and drying)

WP3: Economic feasibility and market demand

- Research question: What is the economic viability of producing micro-algae for animal feed on a larger scale?
- Including analysis of market demands (volume, quality) and organisation of the value chain
- Research design: Economic feasibility study (EFS) and market analysis

More information?

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Interesting partners for consortium

Confirmed

Potential

Regional animal feed producers

Funding possibilities

Possibilities

Rijksdienst voor Ondernemend Nederland

TKI PPS

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Kennis op Maat & Protein Transaction Community Fund

The ROCKEFELLER FOUNDATION

BANQUE AFRICAINE DE DEVELOPPEMENT AFRICAN DEVELOPMENT BANK

AFRICAN DEVELOPMENT FUND FONDS AFRICAIN DE DEVELOPPEMENT

AQUA SPARK

BILL & MELINDA GATES foundation

Unrealisitc

NFP

Netherlands Food Partnership

Rijksdienst voor Ondernemend Nederland

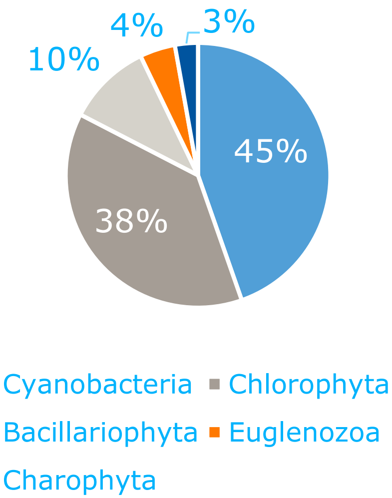
RVO Impact Cluster / PIB

Sea Grant MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Findings from RAS ponds in Tanzania

Species >
The species of microalgae found in the pond water were assessed to genus level. The figure on the right displays the percentage of each phylum in the water sample.

Most microalgae or bacteria found is Cyanobacteria. Depending on circumstances, this can be toxic. It is most likely not useable for human consumption or cosmetics, but often used for fertilizer.



Volume
The total production per harvest was 37.6 kg for two-day intervals, and 69 kg for four-day intervals. The dry matter (DM) was highest for a flushing interval of four days (11,504g DM/harvest).

The production is 48 ton algae/bacteria per hectare per year.

Purity & contamination
Faeces, worms and leftover feeds. Needs to be improved before quality can be guaranteed for e.g. consumption. The bacteria species found in the water samples are Staphylococcus, E. Coli, Bacillus, Streptococcus (only in biofilter), and Klebsiella.

Content
The chemical composition of algae collected from the water is:
- Crude protein: 29%
- Crude fiber: 23%
- Crude fat (ether extract): 3%
- Nitrogen free extract: 45%

Separation techniques
Two techniques were used to separate the algae from the water.
1. Sedimentation: timely, produced fewer algae.
2. Centrifugation: more efficient, more expensive.

Another option is flocculants (Chitin), as a cheaper solution than centrifugation to speed up the sedimentation process. This would be more suitable for fertilizer than feed.

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Potential algae production in East Africa

- The production of algae in the intensive fishpond is 3 times higher than normal in algae ponds (48 ton/ha/year). The ration fish to algae production is 3:1, so the pond (200m^2) yields 3 tons of fish and 1 ton of algae.
- The East African aquaculture sector hosts 17,726 freshwater fish farmers. The average area of a pond is 300m^2. This totals to 532 ha, or a total potential algae production of 25,525 ton per year.

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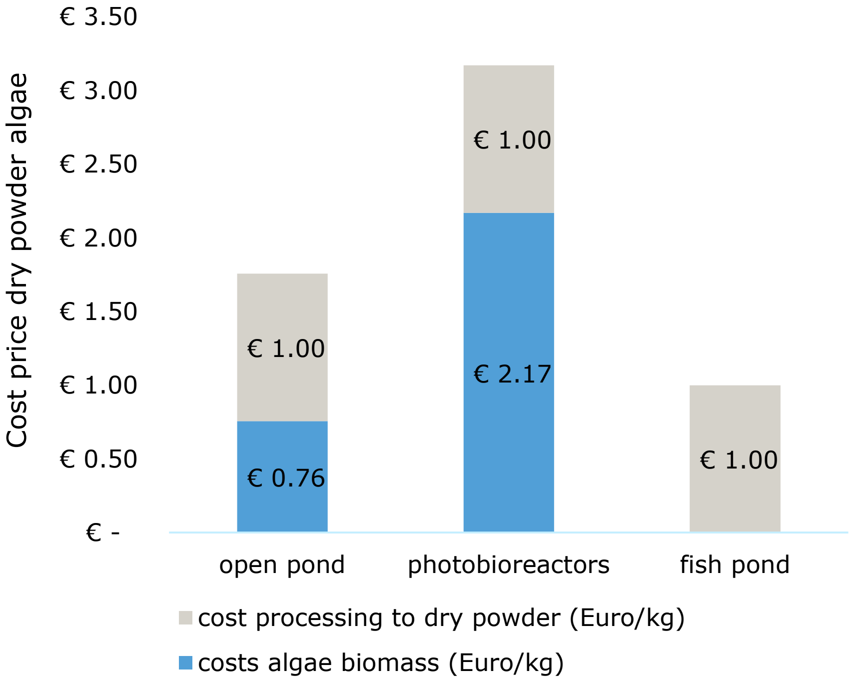
List of interviewees

- Mark Sturme, WUR
- Lolke Sjitsma, WUR
- Hans Reith, WUR
- Rommie van der Weide, WUR
- Ben van de Broek, WUR
- Iago Domiquez Teles, WUR
- Tom Prins, Aqua Spark
- Frank Gort, Nevedi
- Arjen Roem, Skretting
- Harisson Juma – UNGA
- Talash Huijbers, InsectiPro
- Rene Jongbloed, Algaspring

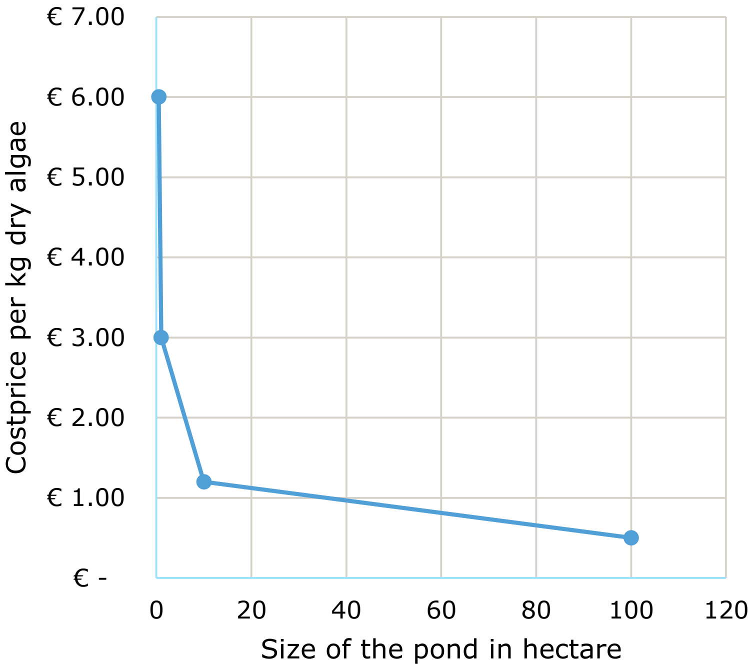
Analysis of algae processing methods

Techno-economic evaluation of microalgae harvesting and dewatering systems

Costprice build-up dry algae powder for differtent production systems



Effect of scale on processing costs of dry algae



Analysis of algae processing methods

Techno-economic evaluation of microalgae harvesting and dewatering systems

Harvesting, dewatering, drying technology	Capital	Complexity	Area requirement	Energy	Quality product	Scale requirement (ton/year)
Centrifugation						50
Spiral plate technology						5
Pressure filtration						10
Vaccuum filtration						10
Membrame filtration						100
Sedimentation						5
Chemical flocculation						50
Drum drying						200
Spray drying						200
Solar drying						5

Analysis of algae processing methods

Techno-economic evaluation of microalgae harvesting and dewatering systems

Harvesting technology	Dewatering technology	(Euro/kg)	Energy usage (kWh)	Drying technology	Costs per kg harvested biomass (Euro/kg)	Total cost algae processing (Euro/kg)
Membrame filter	Centrifuge	1.5	4	Drum/spray dryer	0.5	2.00
Membrame filter	Spiral plate technology	1.5	4	Drum/spray dryer	0.5	2.00
Pressure/ vacuum filter	Spiral plate technology	0.5	1	Drum/spray dryer	0.5	1.00
Pressure/ vacuum filter	Centrifuge	1	2.6	Drum/spray dryer	0.5	1.50
Flocculation (chitosan)/ flotation	Pressure/vacuum filter	0.3	0.1	Drum/spray dryer	0.5	0.80
Centrifuge	Spiral plate technology	0.5	2	Drum/spray dryer	0.5	1.00
Spiral plate technology	Centrifuge	12	2.2	Drum/spray dryer	0.5	12.50

- Pressure/vacuum filter seems the best option for animal feed. The alternative, sedimentation, requires a large surface and has a low efficiency.
- Chemical flocculation seems the best option for fertilizer. However, this is not suitable for animal feed.

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Processing needed for animal feed

- Step 1: Extraction of micro-algae via biofilter
- Step 2: Separating water and algae through sedimentation / drying by sun
- Step 3: Sterilization
- Step 4: Transport to regional animal feed factory / neighbor land

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