



The New Frontier: upscaling seaweed farming

how the crop start is controlled for optimal yields

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Seagriculture USA 2024, Ketchikan



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Profile Job Schipper

Background: WUR Plant Science 1986; Seed industry; Naktuinbouw

Founder at Hortimare: 2008-2020

Projects & Consultancy: SEAWISER (www.seawiser.com)

R&D lab: NIOZ Texel

Today advisor/developer with SEAWISER and partner in SWD Connectors:
(www.swdconnectors.com)



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Priorities in large scale farming

- Economy: a competitive and reasonable cost and price
- Product: a year-round demand for biomass
- Supply: a year-round production of biomass (continuous crop)

- Site selection: offshore sites, enabling year-round farming
- Technology: rigs, mechanization and biotechnology
- Biology: best suitable species; selected varieties

- Operations: smart planning; monitoring; risk mitigation
- Management: SEALOOP model for predictability

Requirements for large scale farming

Requirements for a crop with the lowest cost/kg:

- Size of the farm: > 10.000 mton ww
- Continuous crop, not just seasonal
- Robust perennial kelp species
- Low maintenance cultivation rig
- Depth 30-80 m
- High level of mechanization

Biological conditions:

- Fouling pressure low: escape from sources of spat and spores
- Nutrients, light, temperature



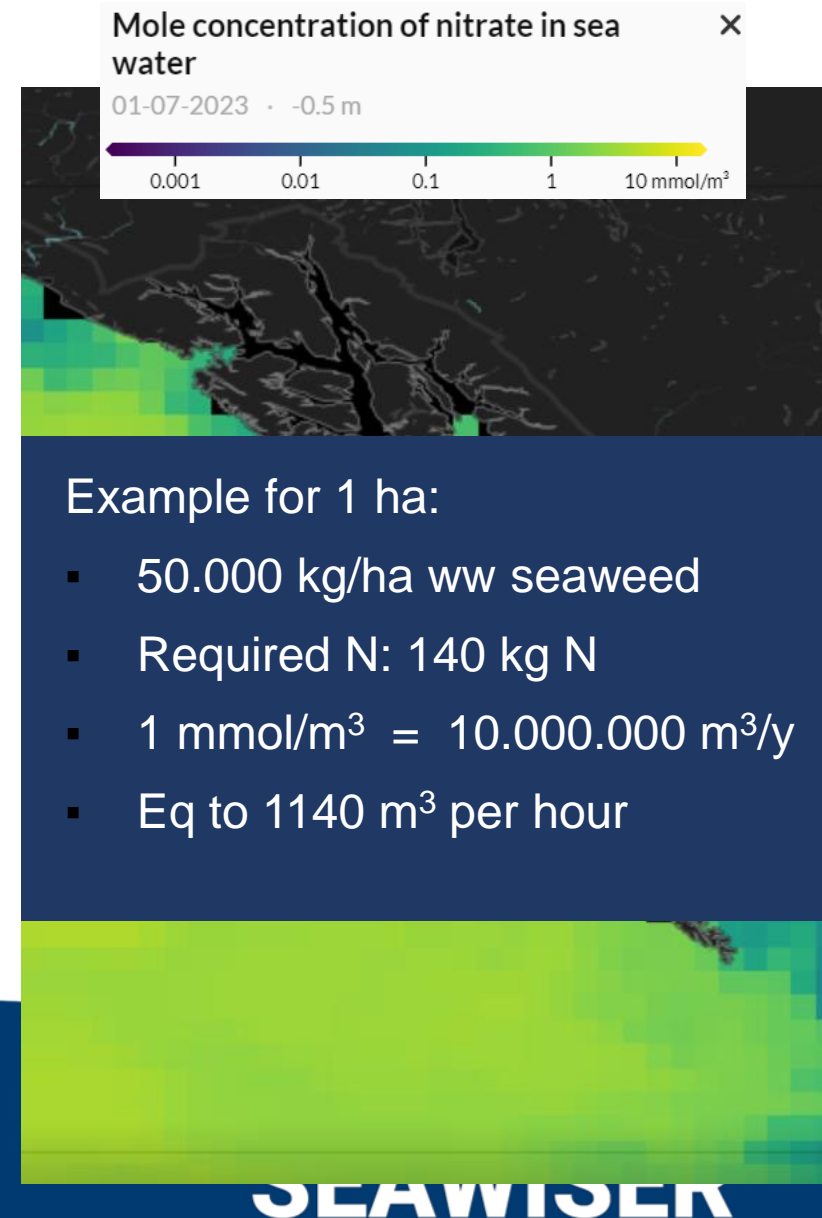
How to compete with fouling?

First criterium for a suitable site: nutrient flux!

high flux - low concentration

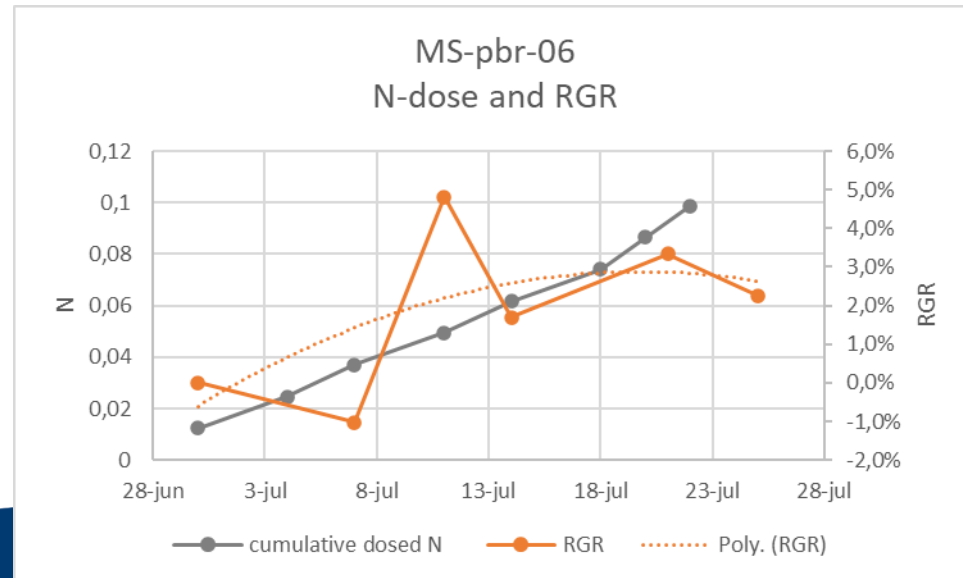
Nutrient flux versus concentration:

- Micro algae drift in a volume water:
concentration-dependent
- Macro algae are fixed in a current:
flux-dependent



Gametophyte bulk production

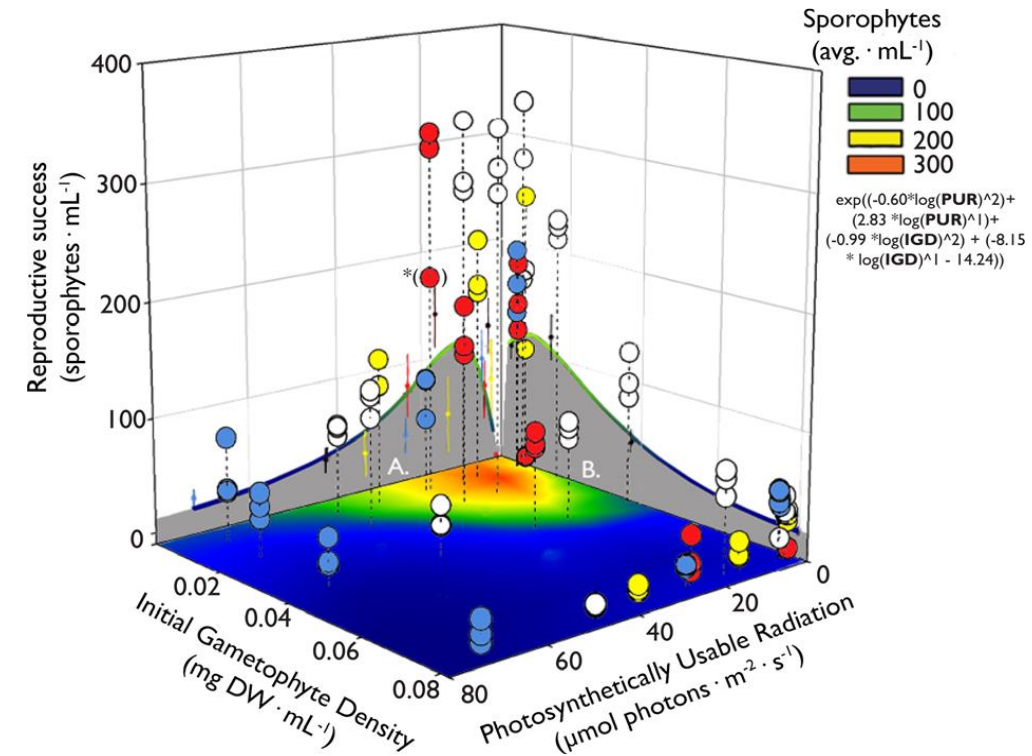
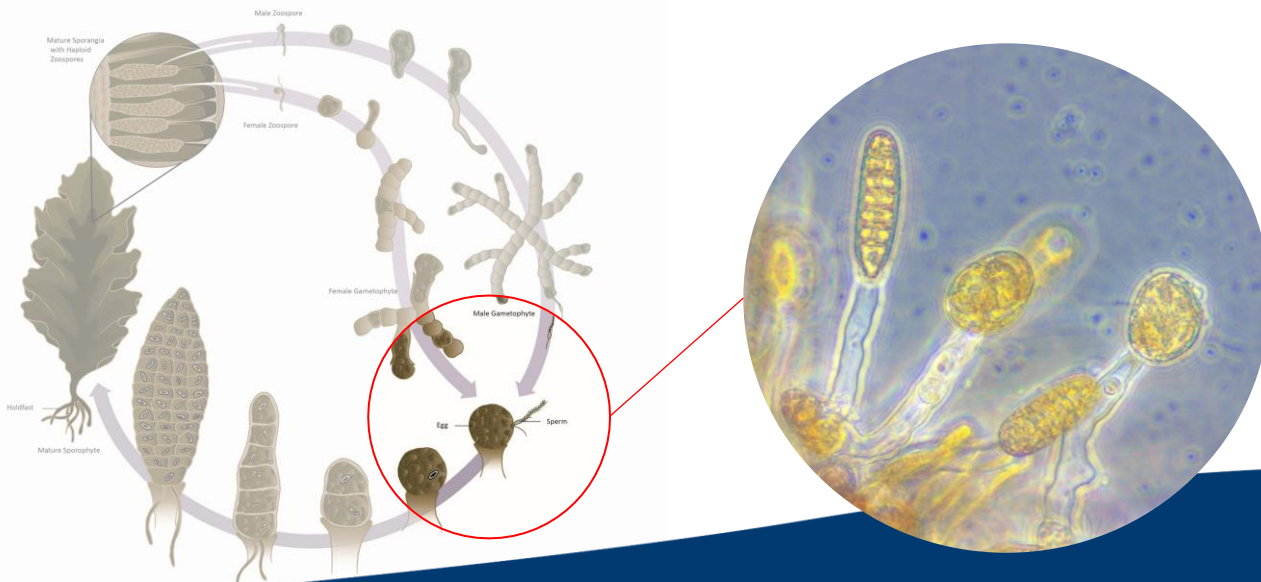
- Compact bioreactor and storage concept:
 - 3 kg gametophytes/year
 - produce about 2000 ton kelp/year
- Fully automated; low labour intensity



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Gametophyte bulk induction (for direct seeding)

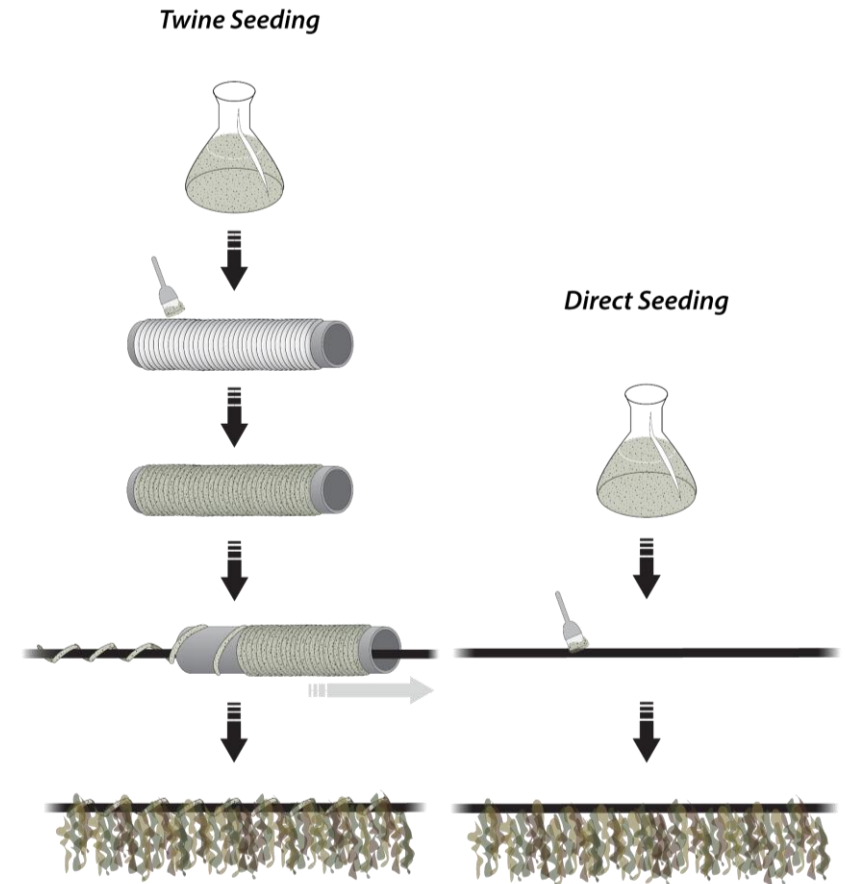
- Induction concept: mechanization is difficult
- SEAWISER has developed a blueprint for which we seek a partner and investor



A. Ebbing et al 2020

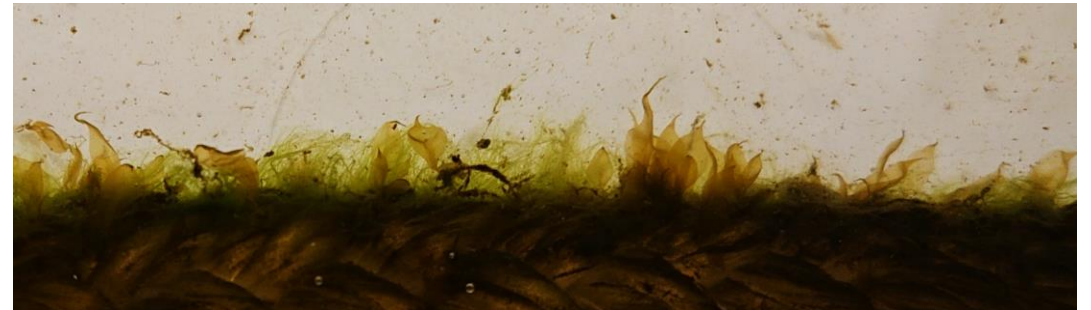
Twine seeding

- Twine seeding advantage:
 - Quick development out at sea
 - Robust seedlings
- Twine seeding disadvantage:
 - Labour intensive
 - High demand for space (climate room)
 - Susceptible for infections/failure during hatching
 - Deployment is difficult to mechanize and slow
 - Reminders of twine in the crop



Direct seeding

- Direct seeding advantage:
 - Precision dosing of seed
 - Scalable method for offshore farming
 - Fast/short at sea; using weather opportunities
 - Significant lower cost:
 - No hatching period is needed
 - Easier and more economical logistics
- Direct seeding disadvantage:
 - Slower initial development (lag phase)
 - Susceptible for competition (fouling)



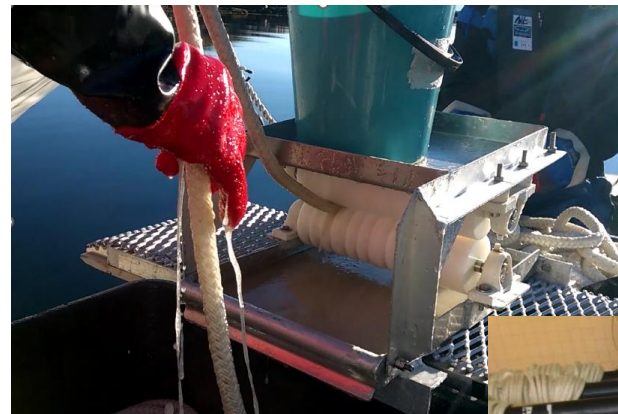
Direct seeding in practice

- Specifically for large-scale farming (starting from 25 km rope)
- Continuous crop (multi-annual)
- Cope with fouling pressure by site selection and timing of seeding





2012



2014



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OCEAN RAINFOREST

SUSTAINABLE NORDIC SEAWEED



MACRO SYSTEMS

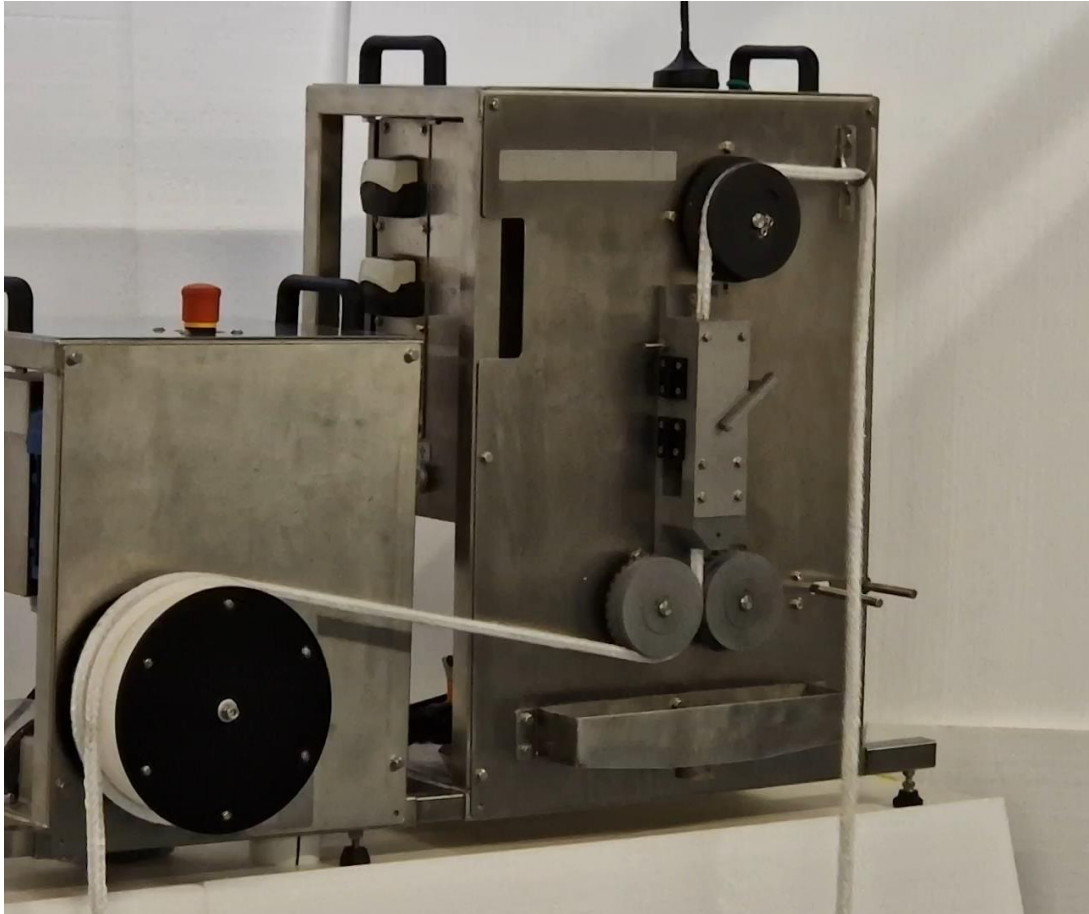
2020



2022



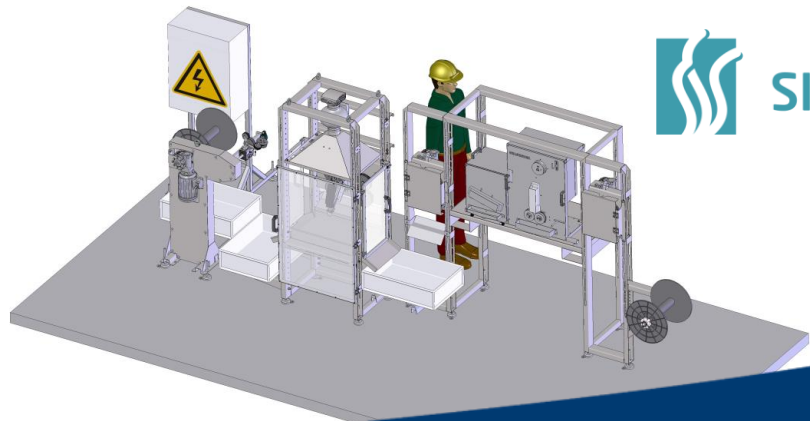
Motorized – 0,3 m/s (1 km/hr)



- Seeding ropes in continuous mode or spot seeding
- Seeding rope diameters from 10 – 14 mm
- Changeable seeding nozzle and wheels
- Hand-pulled or with an optional winch
- Built with quality parts for low maintenance
- Standard SEASEEDER seeds 1000 m/hr

HS-SEASEEDER - 1 m/s (3,6 km/hr)

- High-speed version of the Seaseeder
- Automated rope handling
- Automated length calculator
- Automated rope cutter (soon)

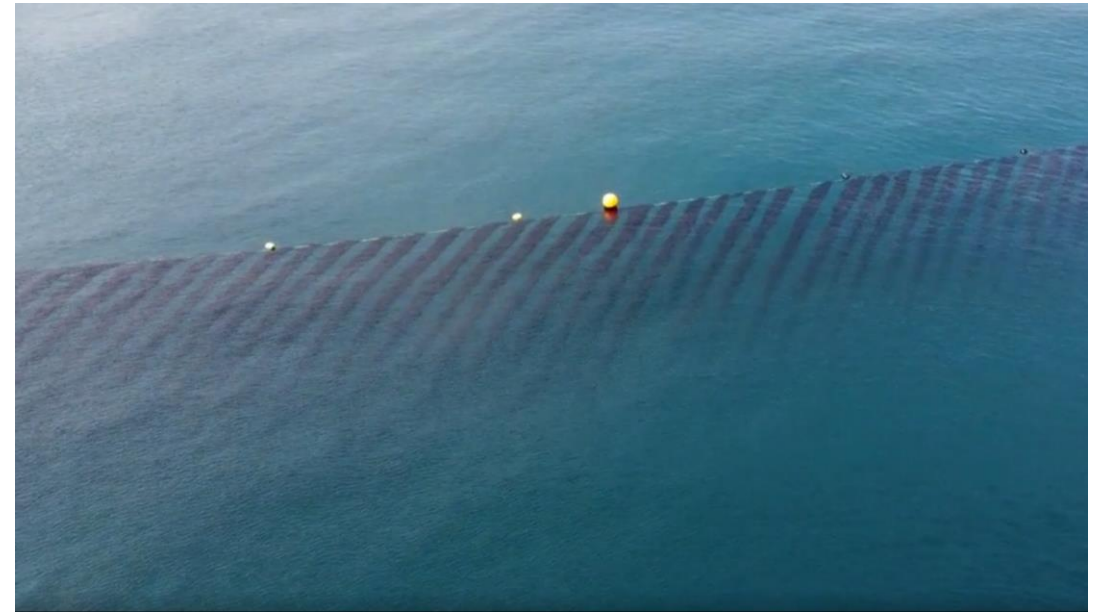
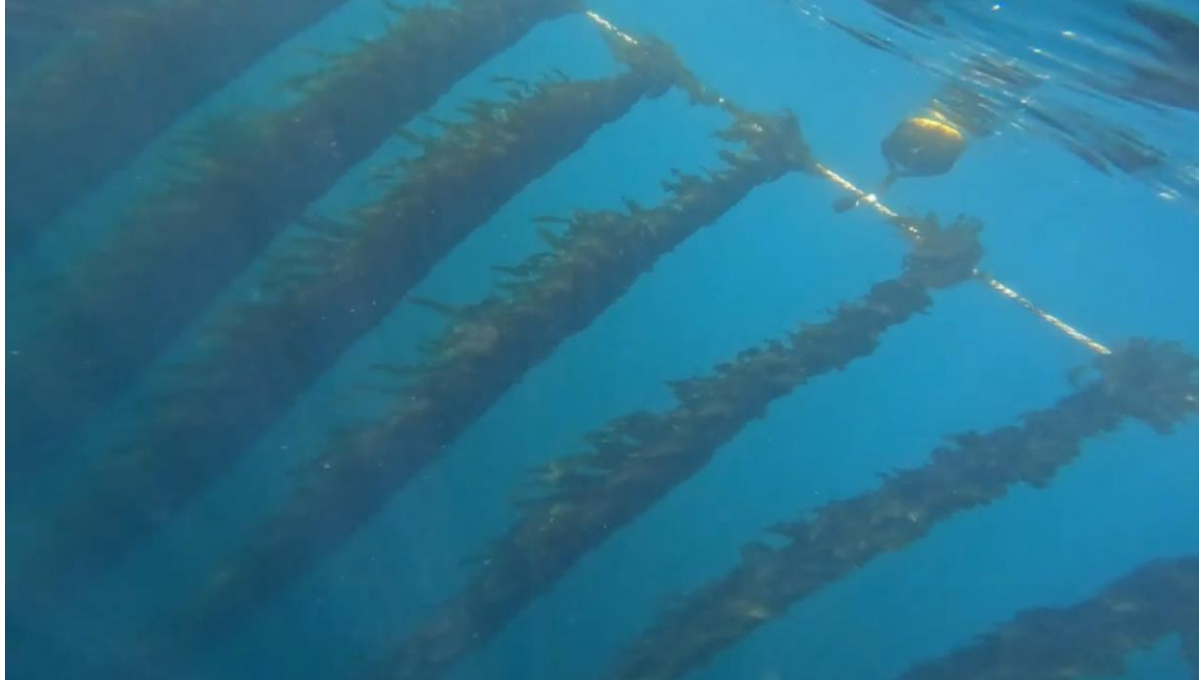


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Results in practice



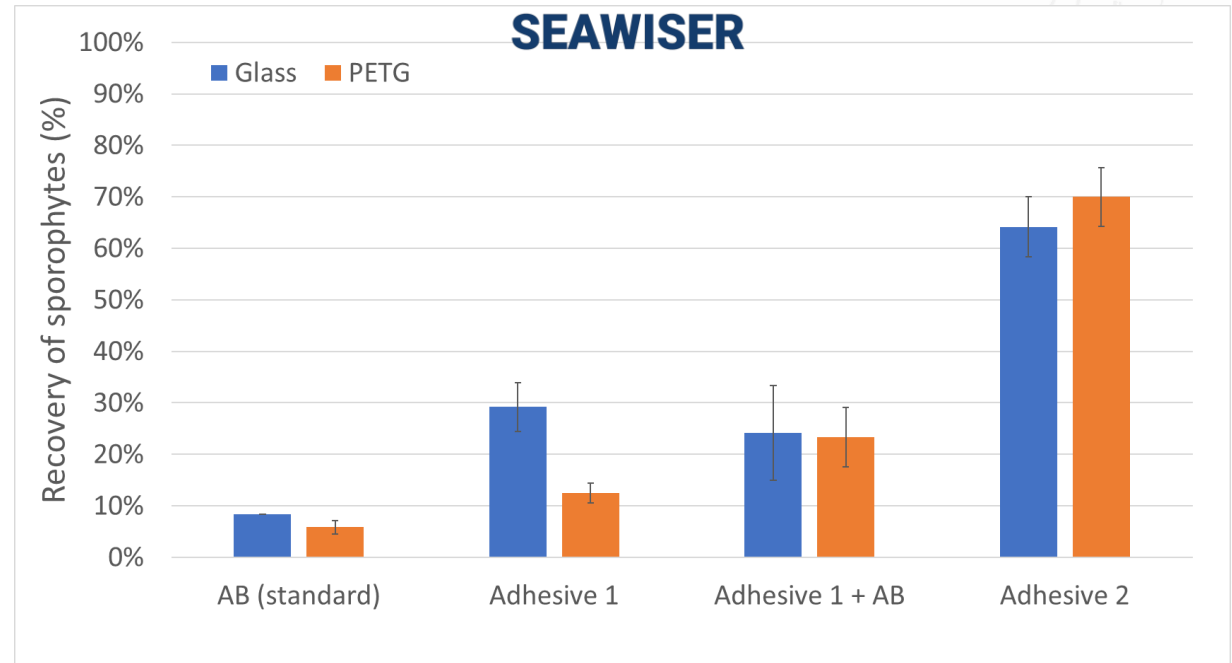
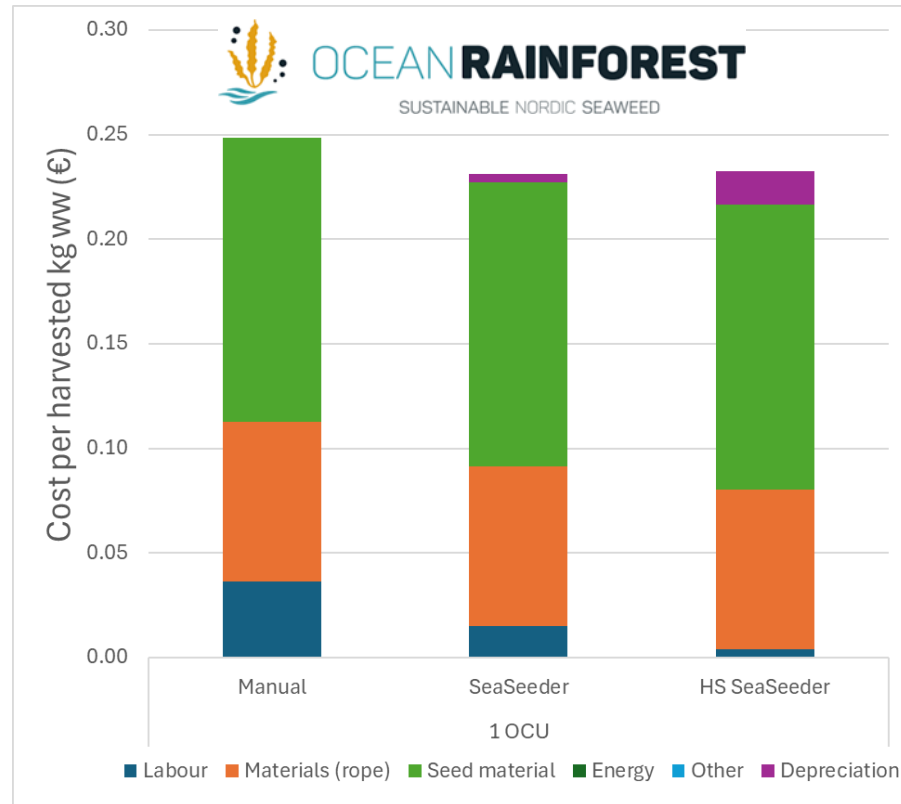
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Cost comparison



	Manual	Sea Seeder	HS Sea Seeder
Machine speed (m/s)	-	0.4	1.0
People needed	5	4	2
Spools per hour	-	2.5	4.5
Meters per spool	-	550	550
Meters per 8h day	5,000	9,625	17,325
Days needed to seed 1 OCU (82,500m)	21	11	6
Labour cost (€)	23,003	9,560	2,655
Equipment cost (€)	-	20,000	80,000
Depreciation years	-	8	8
Equipment cost / year (€)	-	2,500	10,000

Improved glue



Take home messages

- Prioritize the site selection criteria for optimal growth (low fouling pressure), to enable a continuous multi-annual crop, above other criteria
- Reduce the costs of 'seed' as much as possible by bulk gametophyte production and precision seeding
- Include direct seeding already in an early stage of the development of the farm to a large-scale operation to get experienced

Special thanks to:



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