

Predictive modelling of large scale algae biomass production

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Introduction

The position of algae in the production of biochemicals and biofuels is emerging. Large scale production facilities are necessary to fulfil the expected future demand. The design of such large scale systems is not straightforward, biomass productivity and economic feasibility are related to the type of reactor, cultivation location, production scale, substrates and operating conditions.



Figure 1: Most common cultivation systems at AlgaePARC, Wageningen. From left to right: open raceway pond, flat panels, horizontal tubes.

Predictive modelling

Models to estimate algae biomass production that include the interaction between changing light conditions and algae growth have been developed. The effect of decision variables like location, algae species, reactor design and operating conditions are included (Figure 2).

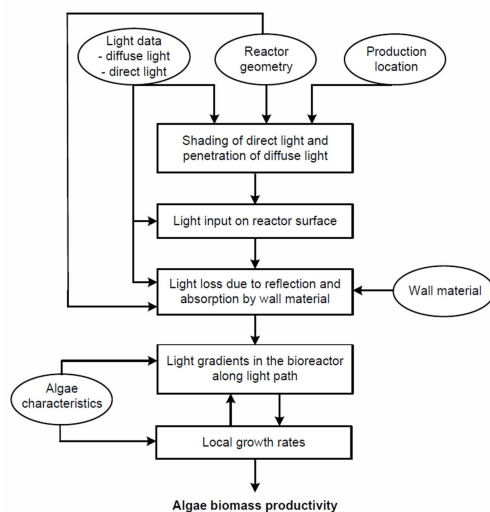


Figure 2: Calculation scheme to determine algae biomass production. Decision variables are given in the circles.

Conclusions

The developed models give insight in the complex effects of location and design variables on algae biomass productivity.

- Light path, biomass concentration, distance between reactors have interacting effects on productivity
- Latitude and sunlight conditions of location affect the magnitude of possible algae production
- Best reactor design is location dependent, best operating conditions depend on algae species

Scenario analysis

Scenario studies were performed to systematically quantify the effect of design and operating variables on productivity. Figure 3 shows that biomass production in raceway ponds is increased when water temperature is controlled. This additional production is accompanied by higher costs for temperature control. Figure 4 illustrates that the combination of tube diameter and biomass concentration have a large effect on achieved algae production.

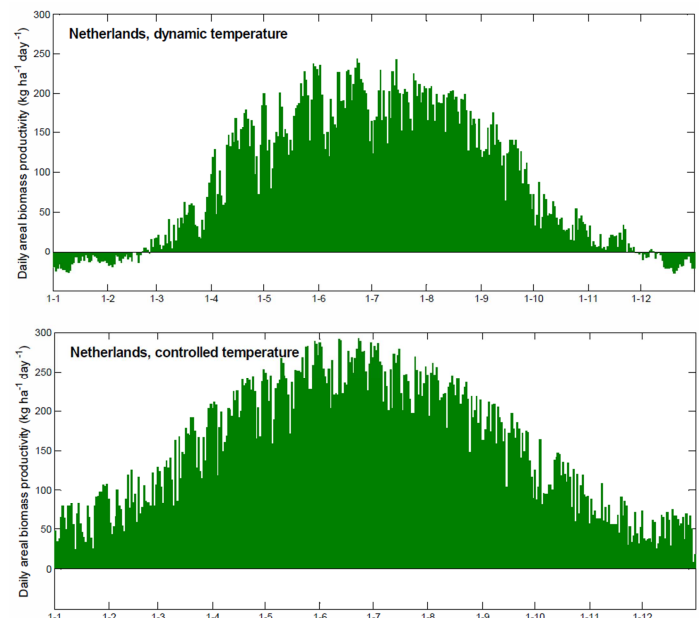


Figure 3: Effect of water temperature of 0.30 m deep open raceway ponds on daily areal biomass production using best constant biomass concentration.

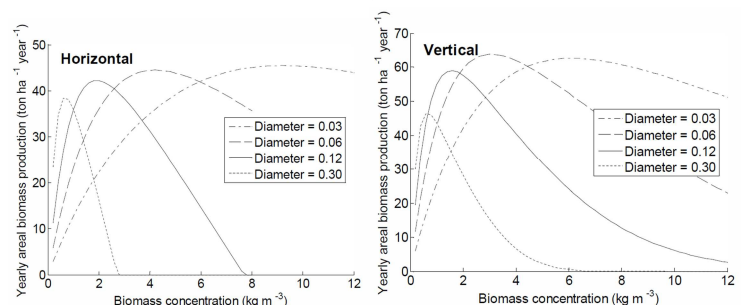


Figure 4: Effect of biomass concentration and tube diameter on yearly areal biomass production for horizontal (left) and vertical (right) tubes.