

Apparent Conflict in the Determination and Reporting of Open Pond Algae Oil Production

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Solar-based Open Ponds

Typically reported potential lipids production rates for open ponds range from 5,000 up to 15,000 gallons of oil per acre per year. The higher end represents anecdotal projections and maximum short-term growth rates achieved in non-production, laboratory settings. The low end of this productivity range is used by recognized reputable agencies such as the U.S. National Renewable Energy Laboratory (NREL), which has published lipids production rates in the range from 1,000 to 6,500 gallons of oil per acre per year.

Let us then consider herein a representative sampling from which one can develop a set of basic operating conditions and its associated production expectation, and then explore if those numbers stand up to a very simple reality check.

For example (Figure 1), using data from Sandia/NREL (Pate, 2008), an average of *estimated* production rates in 3 different climatic settings (Arizona, Mid-West, and South-East U.S.) yields the following productivity, assuming a (what I consider to be a somewhat generous) 50% by weight oil extraction from dry algae:

Figure 1.

Averaged 3-climate Production Data

Pond Algae Production (NREL)	
Oil gal/acre/year	5026
algae dry $\text{g m}^{-2} \text{day}^{-1}$	23.8
oil extraction %	50%

This is but one representation, yet one generally considered by the algae community to fall towards the more conservative and realistic end of the typically-touted open pond production range from 5,000 up to 15,000 gallons of oil per acre per year.

Considering now the following (Figures 2 & 3) representative samplings of publicly available published results, BioPhotix has determined some average reported values for practical open pond production rates for:

- Dry algae yield per day, in grams per m²
- % oil extraction as a function of dry algae weight
- Gallons of oil per acre per year

Figure 2.

Annual Oil Production per Acre

Pond Algae Oil Yield: Gallons/Acre/Year			
<i>Source</i>	<i>Date</i>	<i>Low</i>	<i>High</i>
Oilgae	2011	335	6111
NREL	2010	1000	5026
Solix	2008	900	1800
Oak Haven PC	2009	1000	1850
Average Yield-	2009-2011	809	3697

Figure 3.

Algal and Oil Production

Pond Dry Algae Yield: g/m2/Day and % Oil			
<i>Source</i>	<i>Date</i>	<i>g/m2/day</i>	<i>Oil %</i>
Benemann	2008	30	50%
NREL	2010	20	25%
NMSU	2008	35	35%
Solix	2008	20	32%
Seambiotic	2007	20	35%
Cal Poly	2007	20	25%
Average Yield-	2007-2010	24.2	34%

Based upon what we feel are “reasonable averages for considered reputable performance data”, one can then develop a single set of numbers that might generally represent the more recent production claims of the algae community. For the purpose of this analysis, BioPhotix is using an initial practical oil extraction rate of 30%, while utilizing the averaged reported pond

algae production rate of about $24 \text{ g m}^{-2} \text{ day}^{-1}$. For consistency and in order to simplify for this example, the following conservatively adjusted representative example (Figure 4) is used:

Figure 4.

Practical Example for Analysis

Pond Algae Production (example)	
Oil gal/acre/year	2000
algae dry $\text{g m}^{-2} \text{ day}^{-1}$	24.0
oil extraction %	30%

Consistent with this example of an hourly average (day and night) algae growth rate of 1 gram of dried algae per m^2 pond surface per hour (i.e., $24 \text{ g m}^{-2} \text{ day}^{-1}$), and at a 30% oil extraction efficiency, the resulting yield of oil is 2,000 gal/acre/year.

This points out that the ubiquitously published “typical yields” of 5,000 to 15,000 gal/acre/year is a factor of about 2.5 to 7.5 times that of “documented yields”. Our industry seems to have wanted to believe that small and tightly-controlled laboratory growth yields are naturally transferrable into large-scale commercial settings. Given such a schism between reality and what appears to be “fantasy taken as truth”, is it no wonder that the algae industry has unfortunately suffered with failing and failed enterprises that unknowingly operate(d) at the “bleeding edge” of insufficiently informed “knowledge”? Caveat Emptor!