INCOVER

Converting HRAP into phototrophic purple bacteria ponds for polyhydroxyalkanoates production from wastewater

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PROBLEM AND SOLUTION

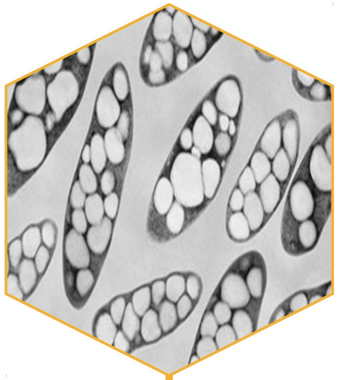
PLASTICS

Essential materials for our society

PROBLEM

ECOLOGICAL NEGATIVE IMPACT

- WASTE
- RESOURCES



PHA

Biodegradable polymer produced by microorganisms and similar to conventional plastics.

SOLUTION

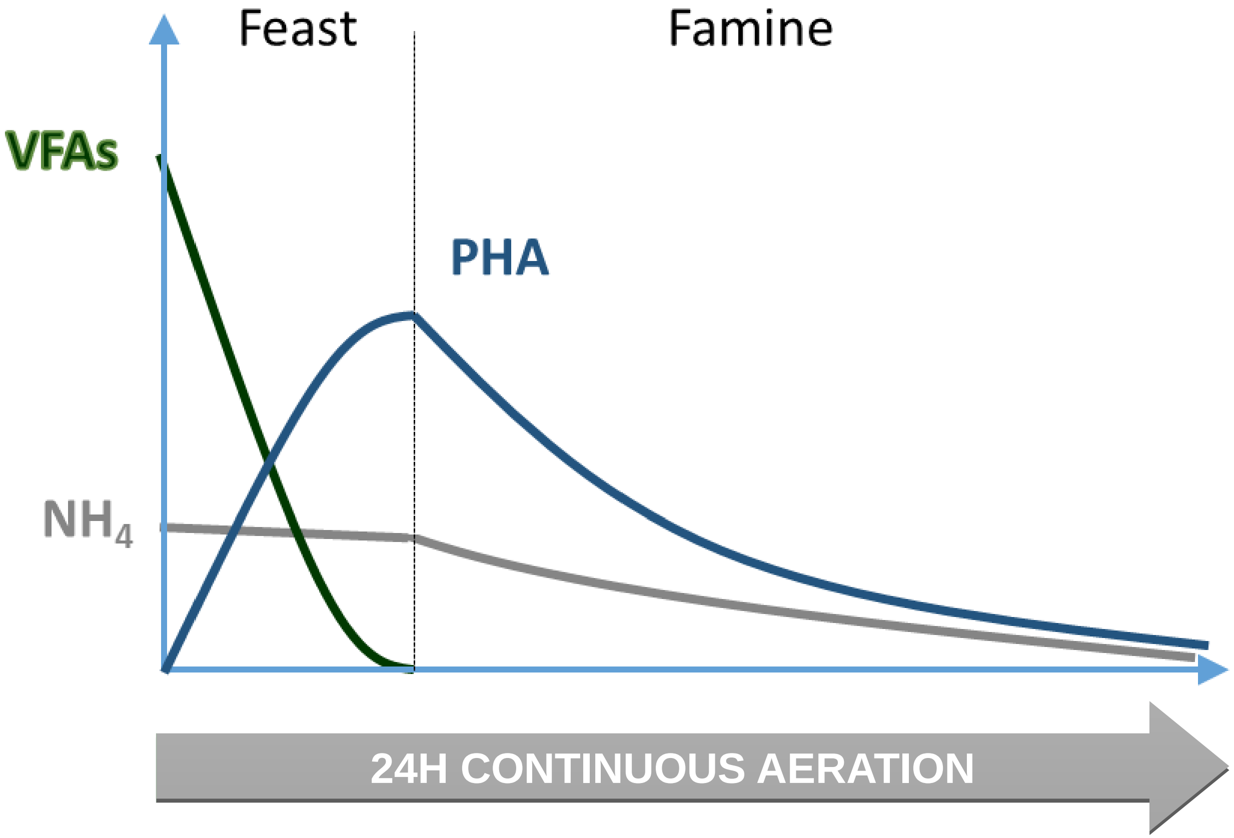
SUSTAINABLE PLASTIC PRODUCTION PROCESSES

- Mixed microbial cultures
- Low cost carbon sources

SELECTION STRATEGY

FEAST AND FAMINE REGIME

FF strategy selects organisms for their capability of growing on the accumulated PHA



PHA PRODUCTION WITH

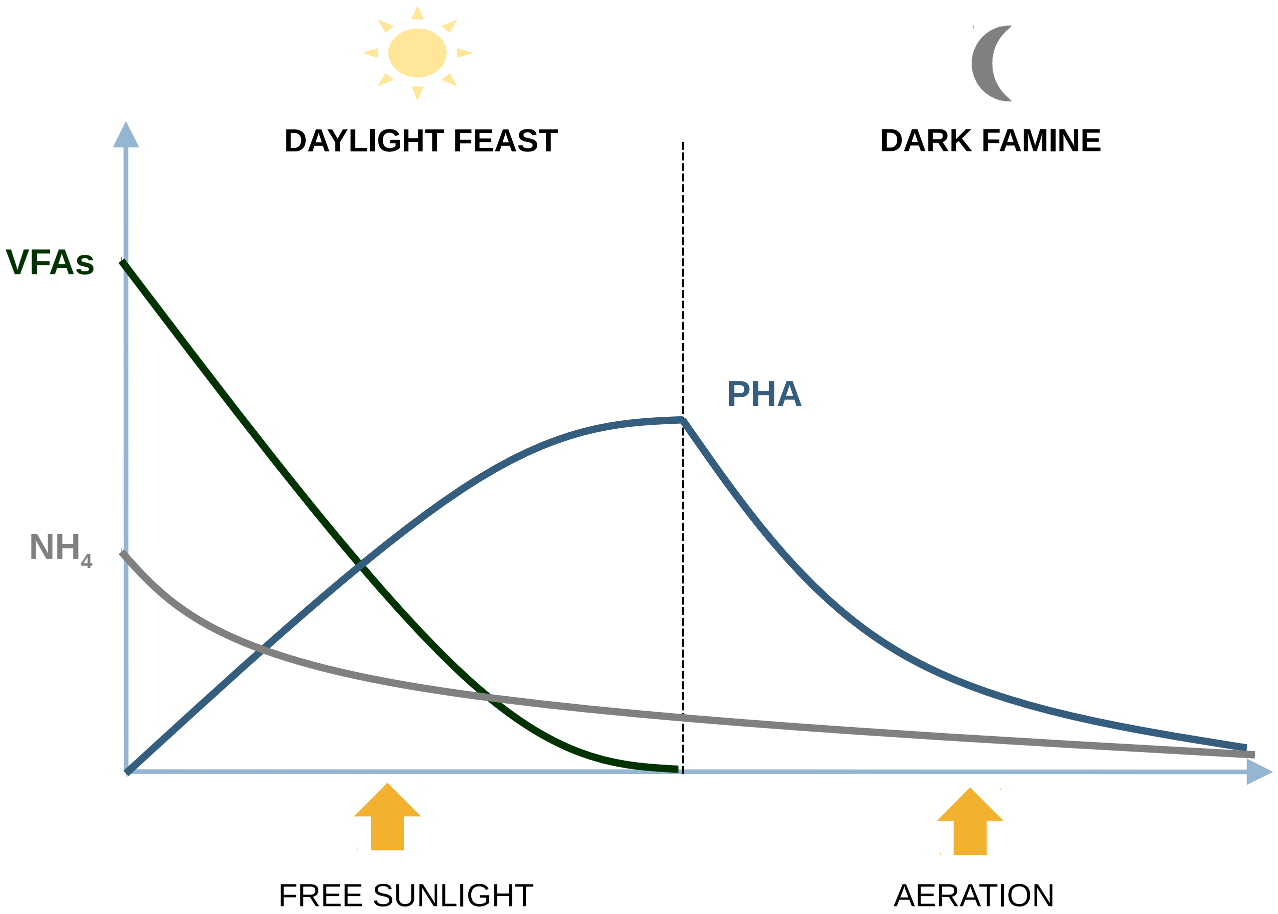
AEROBIC MIXED CULTURES

- **Aerobic organisms:** require intensive aeration

SELECTION STRATEGY

FEAST AND FAMINE REGIME

FF strategy selects organisms for their capability of growing on the accumulated PHA



PHA PRODUCTION WITH

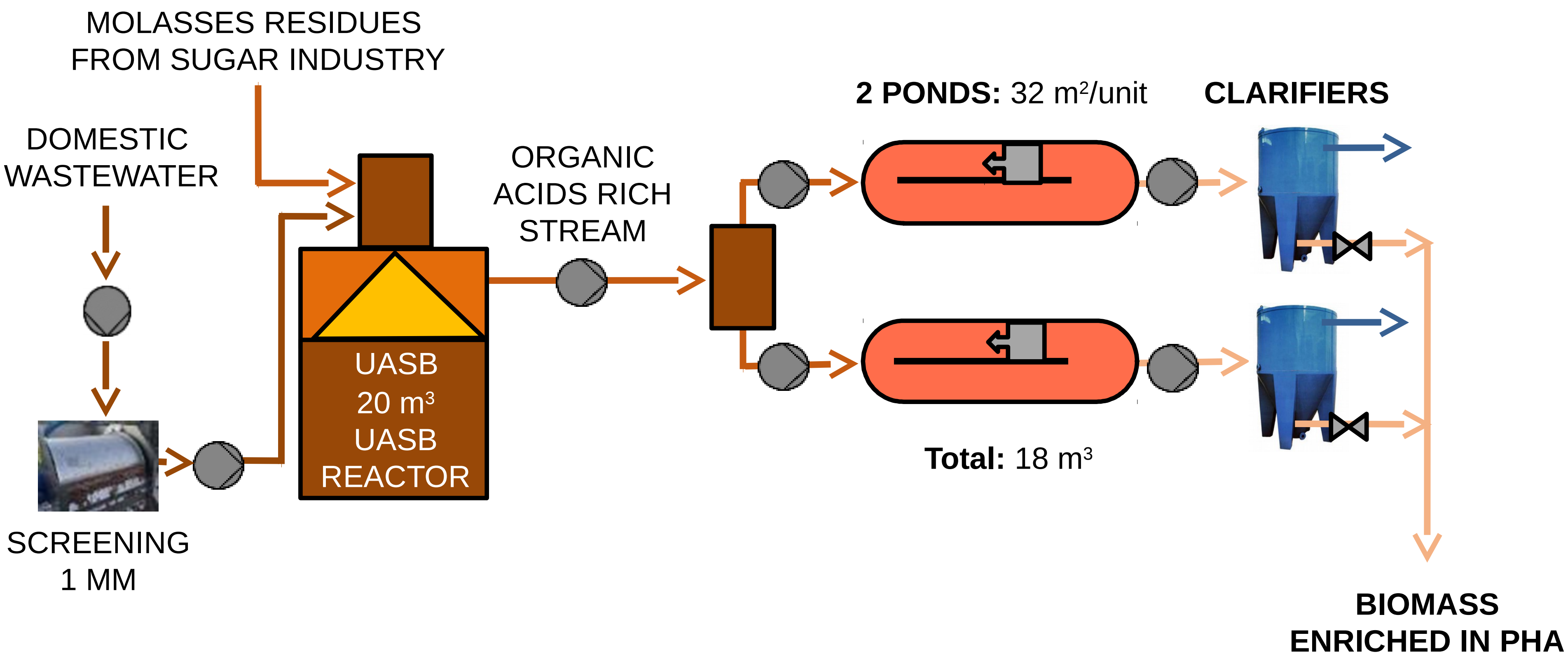
PHOTOTROPHIC MIXED CULTURES

- **Phototrophic organisms:** ATP production independent of oxidative phosphorylation

DECREASED AERATION COSTS

RETROFITTING OF CHICLANA HRAP

*PHA production with **purple bacteria** using retrofitted HRAP*



RETROFITTING OF CHICLANA HRAP

MOLASSES

WASTEWATER

UASB's VFAs stream

Microalgae initial mixotrophic culture

Red-purple bacteria culture

DEMO PONDS OPERATION

FEED SOLUTION

FERMENTED MIXTURE OF WASTEWATER WITH 0,5% (v/v) SUGAR MOLASSES

Fluctuating Feedstock

ADAPTATION PERIOD

BATCH MODE

PERMANENT PRESENCE OF CARBON AND NUTRIENTS

Promote the growth of purple bacteria

FEAST AND FAMINE

FEEDING REGIME

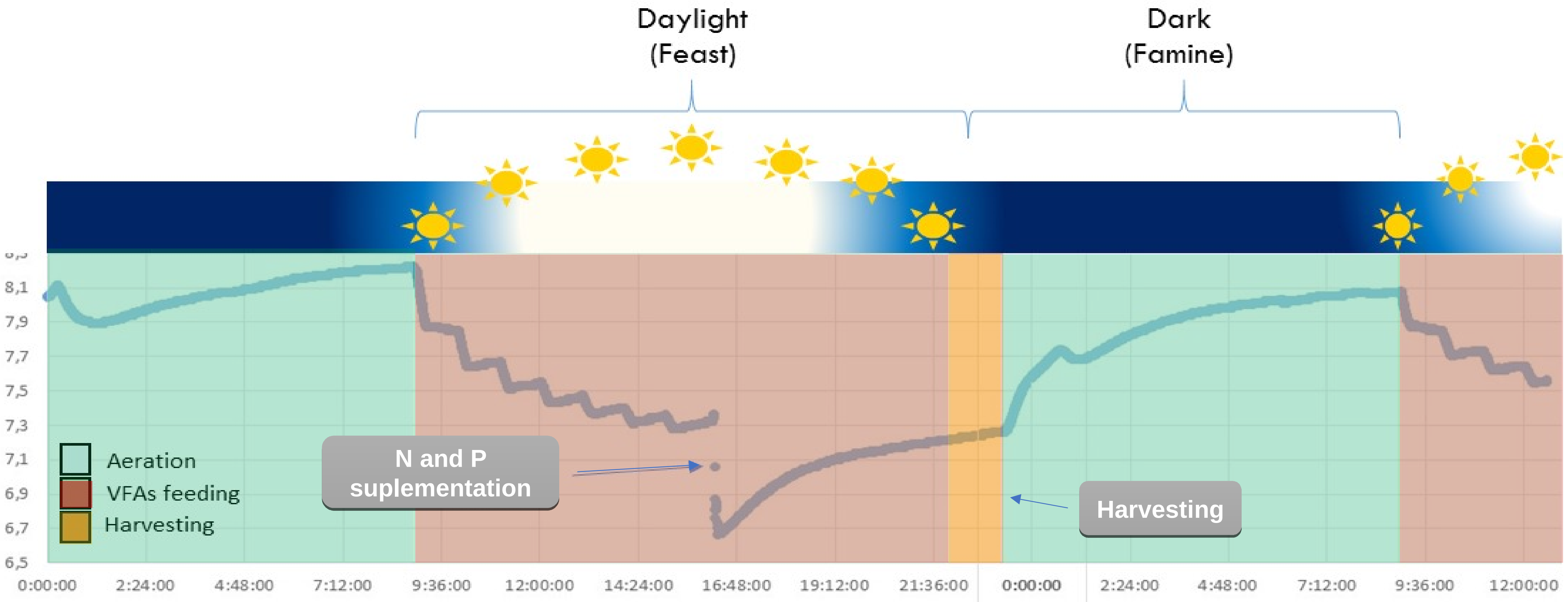
Alternating presence of carbon

24H CYCLE

CIRCADIAN CYCLE
AERATION IN THE NIGHT

DEMO PONDS OPERATION

DEMO PONDS OPERATION



DEMO PONDS OPERATION

JUNE

JULY

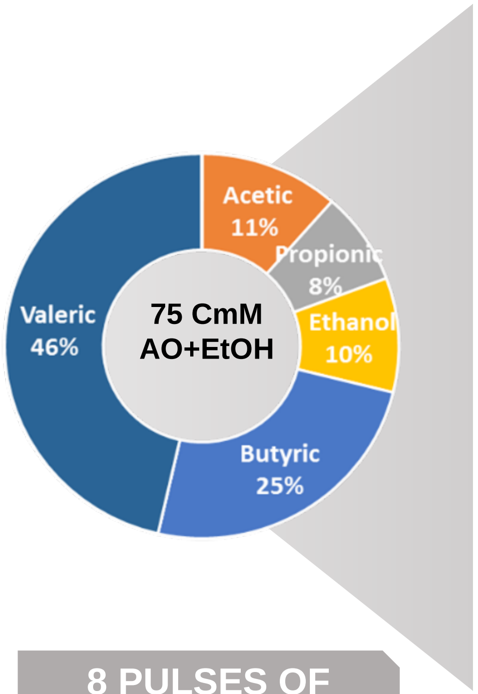
BOTH PONDS WERE DOMINATED BY PURPLE BACTERIA

MAXIMUM IRRADIANCE AND TEMPERATURE REGISTERED IN CHICLANA 2018

POND 1: ENRICHED IN PURPLE BACTERIA

POND 2: STILL PRESENTED A GREEN COLOUR

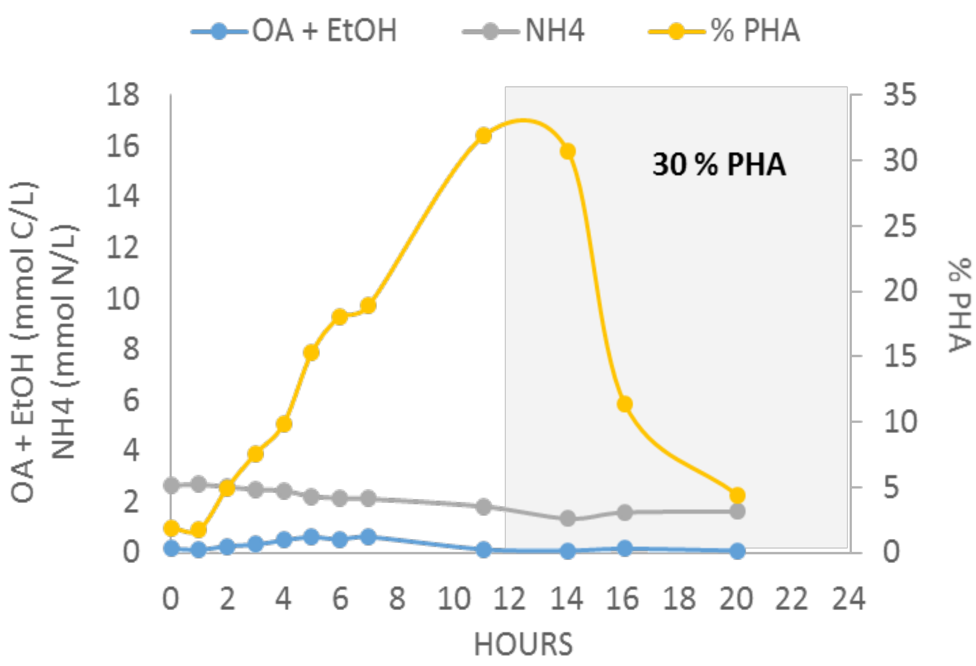
JULY 2018



8 PULSES OF CARBON

12.5 mmolC $L^{-1}d^{-1}$

POND 1)

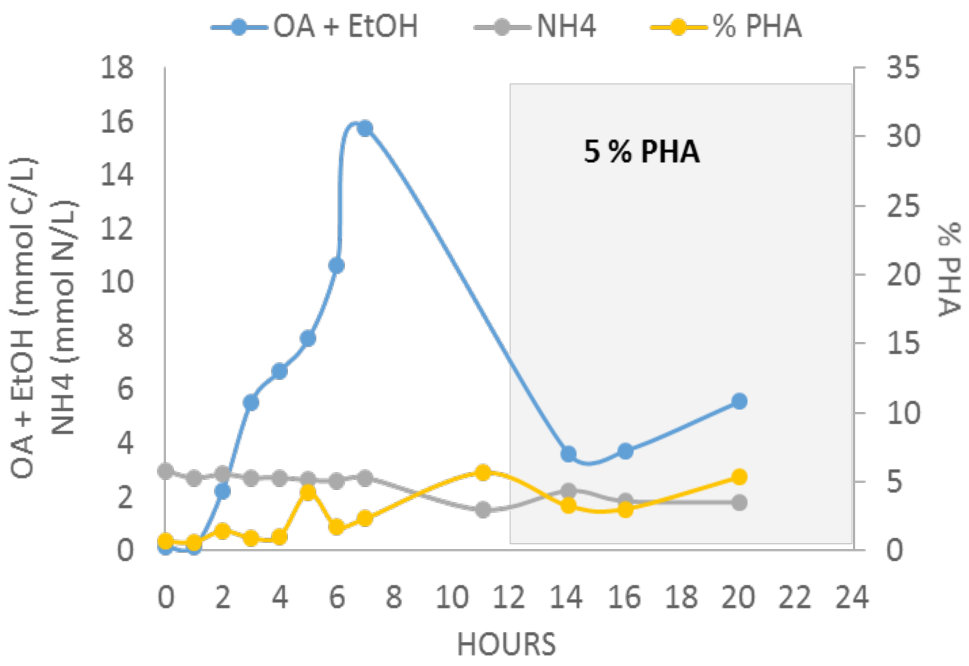


1.9 g VSS · L^{-1}

HB:HV 35:65

ORGANIC ACIDS LIMITATION

POND 2)



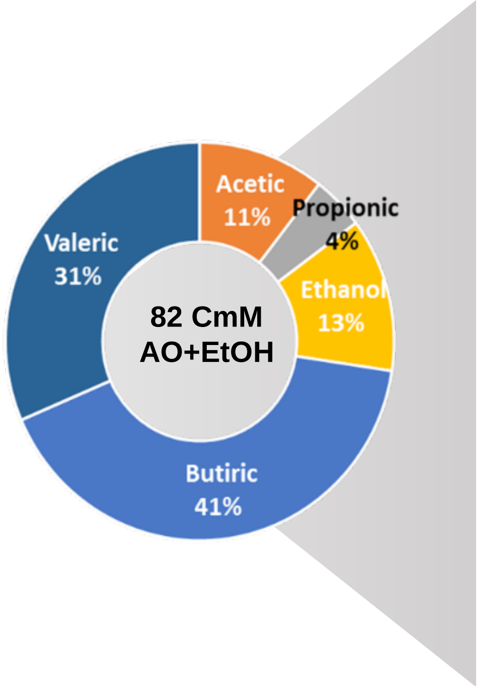
1 MONTH OF DELAY

2.2 g VSS · L^{-1}

HB:HV 65:35

LOW PREFERENCE FOR VALERIC ACID

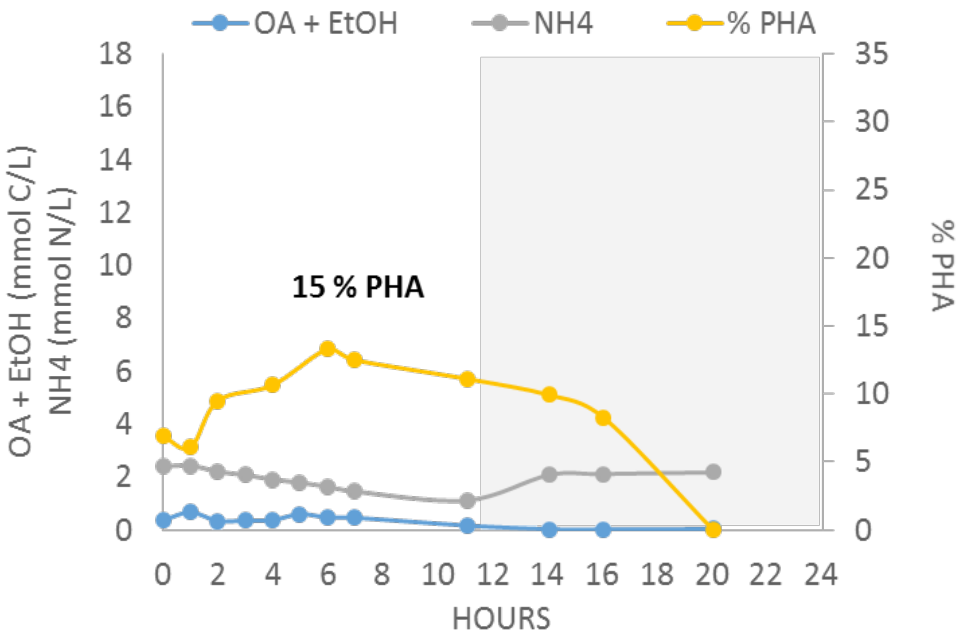
AUGUST 2018



7 PULSES OF CARBON

11.9 mmolC $L^{-1}d^{-1}$

POND 1)

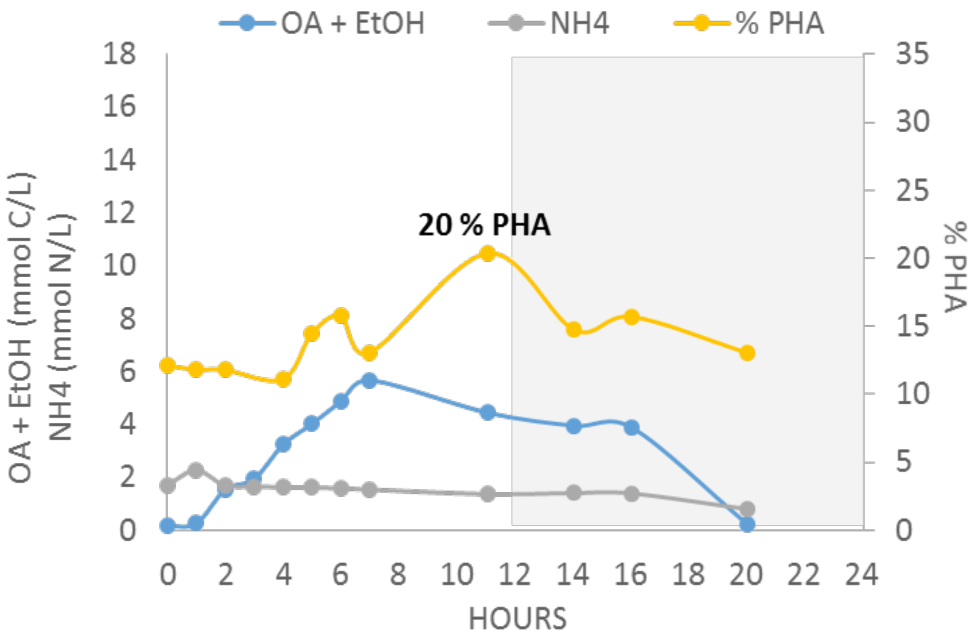


2.7 g VSS · L^{-1}

HB:HV 40:60

ORGANIC ACIDS LIMITATION

POND 2)



1 MONTH OF DELAY

2.3 g VSS · L^{-1}

HB:HV 70:30

LOW PREFERENCE FOR VALERIC AND BUTYRIC ACID

DEMO PONDS OPERATION

LOW IRRADIANCE AND TEMPERATURE
REGISTERED IN CHICLANA

BOTH PONDS BEHAVING SIMILARLY

JUNE

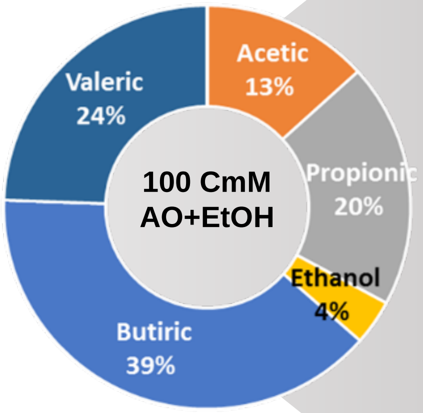
JULY

AUGUST

OCTOBER

APPEARANCE OF FLOATING ALGAE THAT STAYED IN THE
SURFACE AND SHADED THE UNDERNEATH ORGANISMS

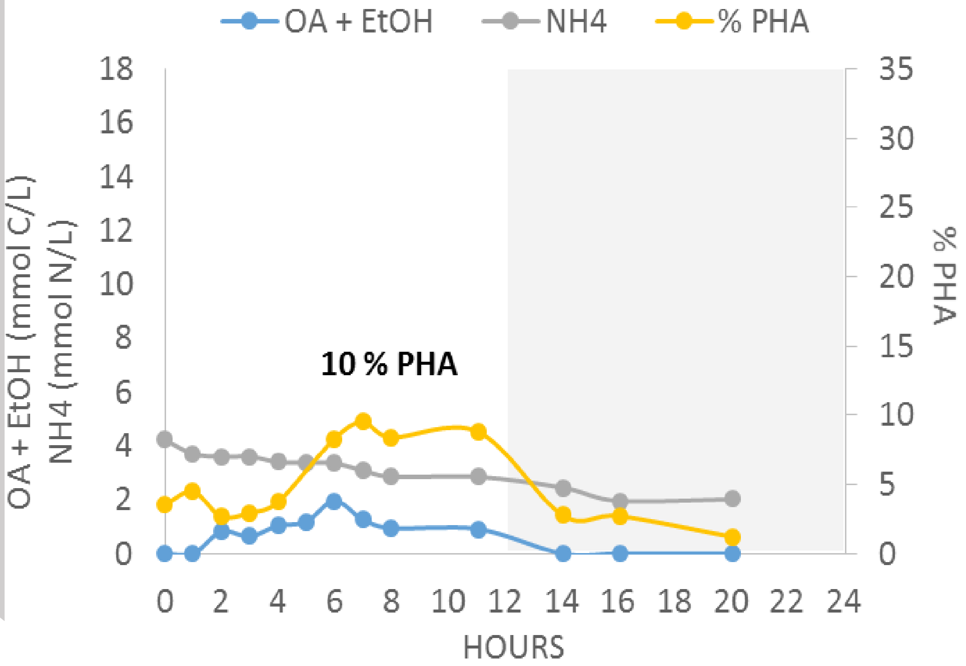
OCTOBER 2018



6 PULSES OF CARBON

12.7 mmolC $L^{-1}d^{-1}$

POND 1)

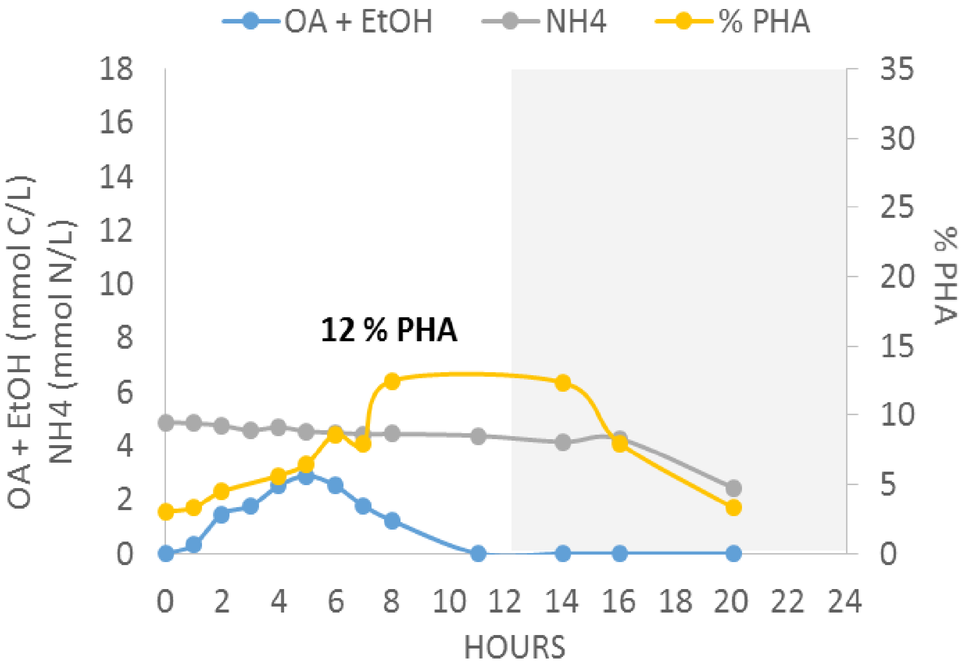


2.4 g VSS · L^{-1}

HB:HV 50:50

ORGANIC ACIDS LIMITATION

POND 2)



2.0 g VSS · L^{-1}

HB:HV 40:50

LOW PREFERENCE FOR VALERIC AND BUTYRIC ACID

PHA PRODUCTION TARGETS

	g VSS/m²d		Kg PHA/Kg VS		g PHA/m²d	
	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2
July	95	110	0.30	0.05	29	6
August	135	115	0.15	0.20	20	23
October	120	100	0.10	0.12	12	12
Project Target	***25 g VSS/m²d***		***0.4 Kg PHA/Kg VS***		***10 g PHA/m²d***	

FUTURE PERSPECTIVES

120 g VSS/m²·d + 0.4 g PHA/g VSS = 48 g PHA/m²·d; 1.5 Kg PHA/pond·d

CONCLUSIONS

- Phototrophic mixed cultures surge as a new and alternative system for mixed culture PHA production.
- HRAP were successfully retrofitted into Phototrophic Purple Bacteria Ponds (PPBPonds).
- With PPBPonds the high cost with aeration that typically occur in aerobic systems during the feast phase are eliminated.
- PPBPonds require only minimal aeration during the famine/night phase.
- PHA contents up to 30% were achieved, a value that is expected to increase with:
  - Higher organic carbon load
  - Favourable influent acid composition.

Acknowledgments

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Thank you all for your attention!

http://sites.fct.unl.pt/bioeng/home