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UNIVERSITY OF
CAMBRIDGE

Algae for Food and Feed

Algae: Food for the Future



Challenges for future food



What are algae?



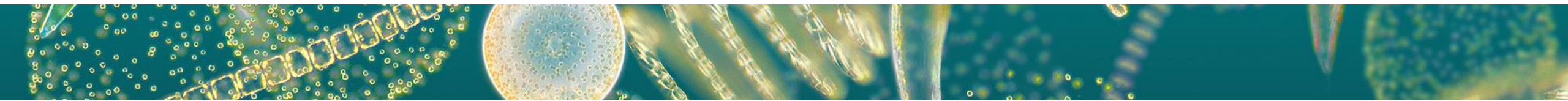
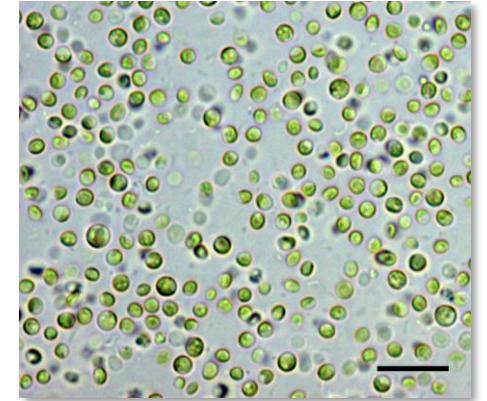
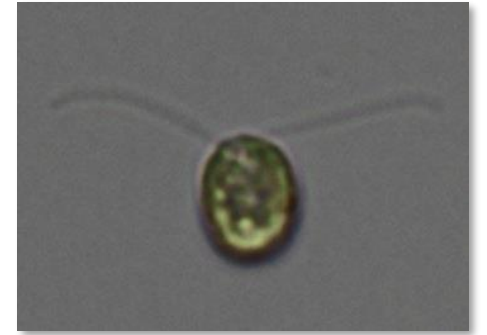
Algae for food and feed

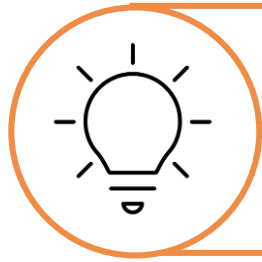


Cultivating algae at scale



Algae for a more circular future





Challenges for future food systems



NO
POVERTY



ZERO
HUNGER



GOOD HEALTH
AND WELL-BEING



QUALITY
EDUCATION



GENDER
EQUALITY



CLEAN WATER
AND SANITATION



AFFORDABLE AND
CLEAN ENERGY



DECENT WORK AND
ECONOMIC GROWTH



INDUSTRY, INNOVATION
AND INFRASTRUCTURE



REDUCED
INEQUALITIES



SUSTAINABLE CITIES
AND COMMUNITIES



RESPONSIBLE
CONSUMPTION
AND PRODUCTION



CLIMATE
ACTION



LIFE
BELOW WATER



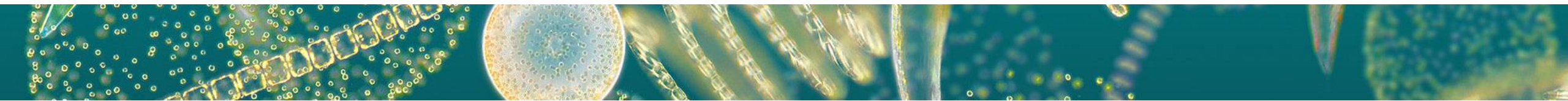
LIFE
ON LAND



PEACE, JUSTICE AND
STRONG INSTITUTIONS



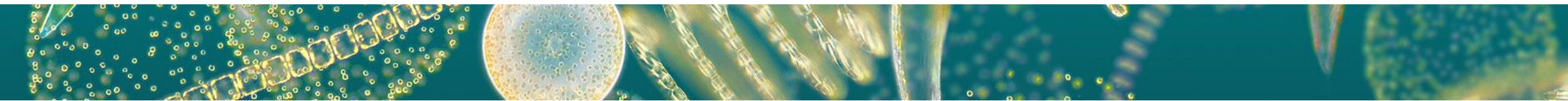
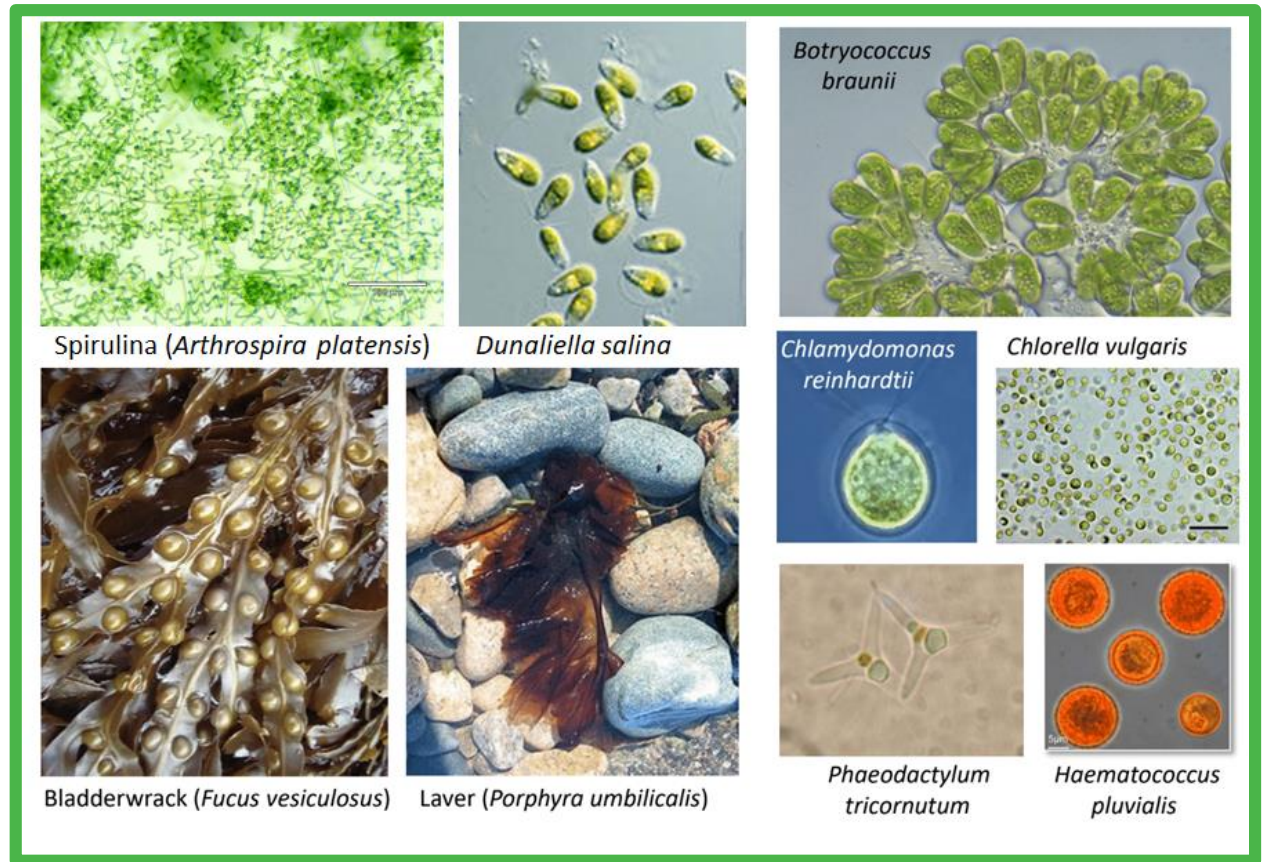
PARTNERSHIPS
FOR THE GOALS





What are algae?

- Photosynthetic, aquatic
- Conservative estimates suggests there are over **70, 000 species** of microalgae (Guiry, 2012)
- **Less than 50** currently used for commercial purposes (EABA, 2020)





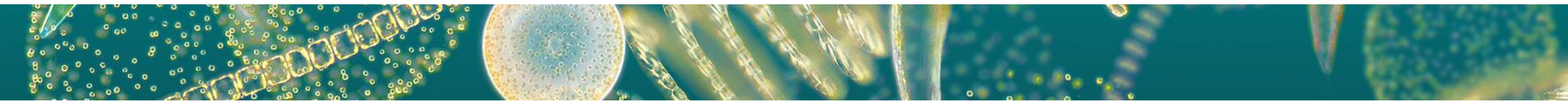
Commercial exploitation of microalgae



Algal Innovation Centre Glasshouse, University of Cambridge



- Photosynthetic growth means potentially more sustainable
- Don't compete with traditional agriculture for land and fresh water
- Fast growth rate (productivity, yield per unit time per unit area, may be 20x > land plants)
- Can be cultivated at industrial scale in photobioreactors

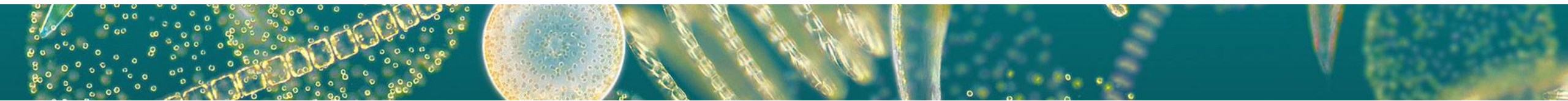




Features of algae for food and feed

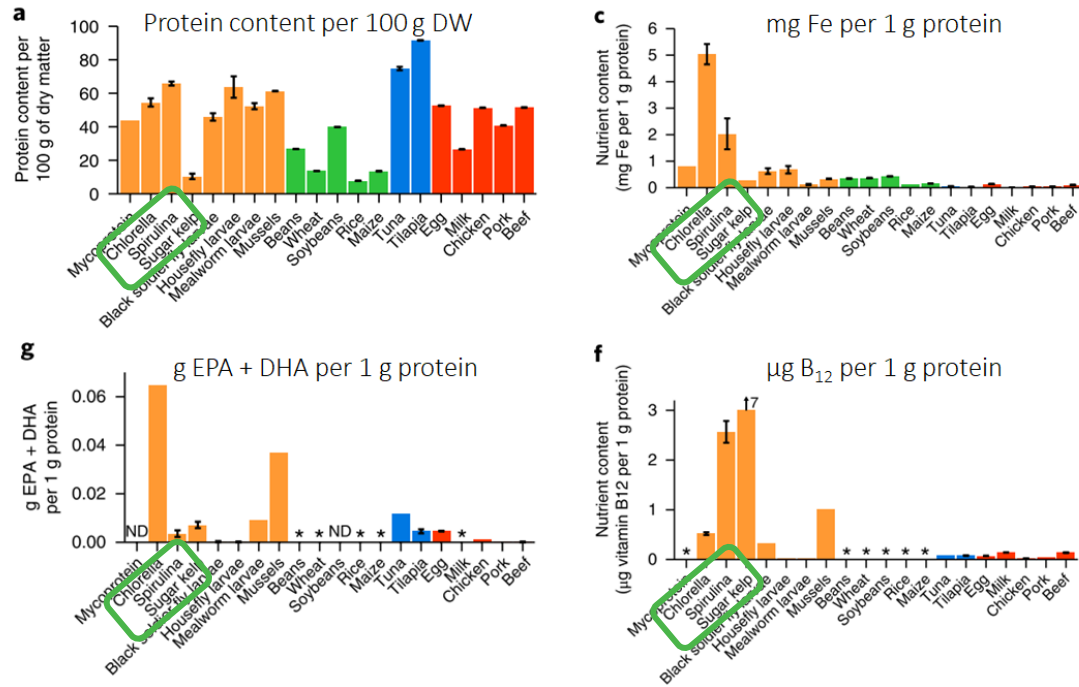


- High protein – balanced amino profile
- Lipid rich, including omega-3 fatty acids
- Many algae classified as GRAS – generally regarded as safe
- High vitamin and mineral content



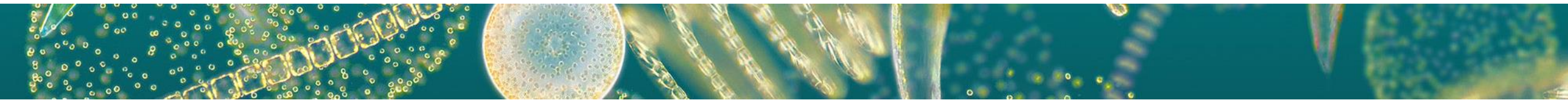


Features of algae for food and feed



Adapted from Parodi *et al* (2018) *Nature Sustainability* 1: 782-789

- High protein – balanced amino profile
- Lipid rich, including omega-3 fatty acids
- Many algae classified as GRAS – generally regarded as safe
- High mineral and vitamin content, particularly B₁₂ (cobalamin)



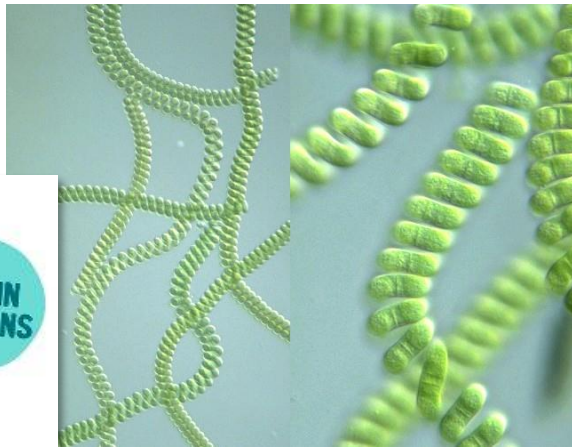


Food ingredients and supplements

- Several extracted products are recognised already
- Two photosynthetic microbes licenced in EU as novel foods

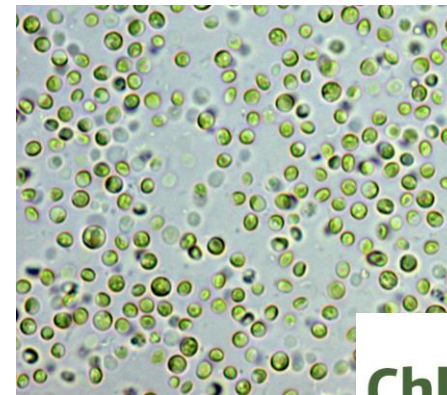


Spirulina (Arthrospira spp.), cyanobacterium



Makes B₁₂

Chlorella vulgaris, eukaryotic green alga



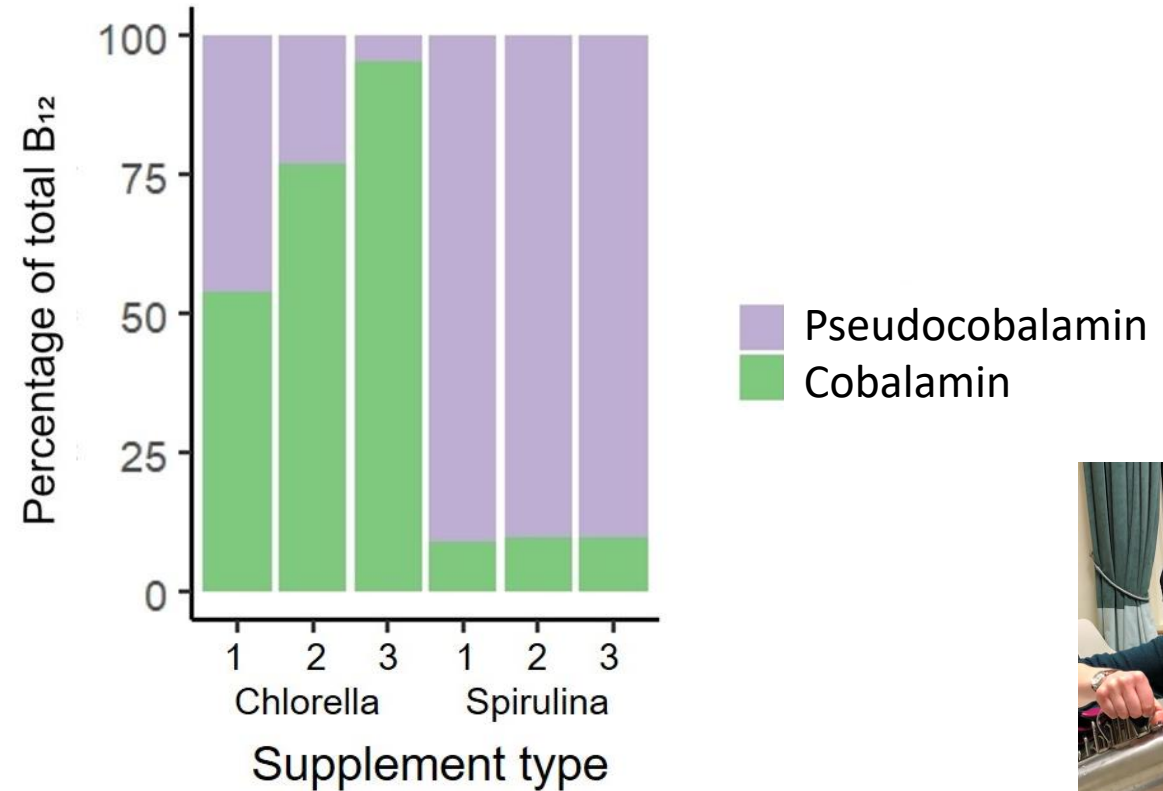
Does *not* make B₁₂ but takes up from commensal bacteria



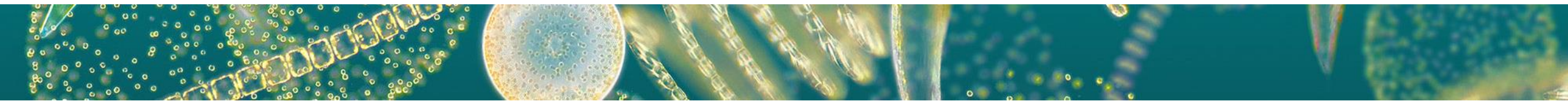


Assaying B₁₂ content of supplements

- Bioassay to distinguish bioavailable B₁₂ from other analogues



Ellen Harrison





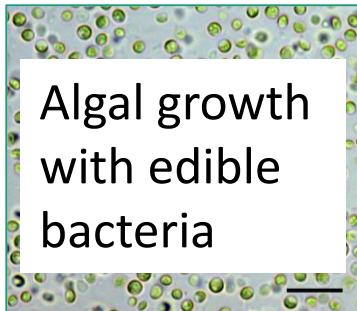
Can algae provide bioavailable B₁₂?

- Increasing vitamin B₁₂ availability in India
- Dietary intervention trials in Pune

University of
Kent



Martin Warren
Ranjan Yajnik



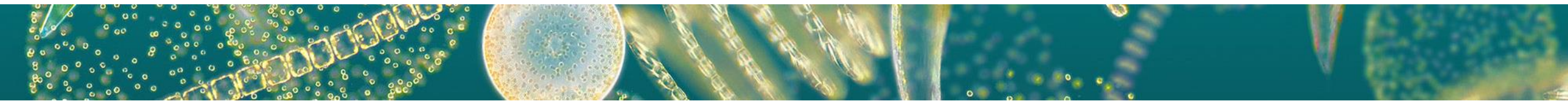
Algal growth
with edible
bacteria



**Algal Biomass
with high B₁₂ content**



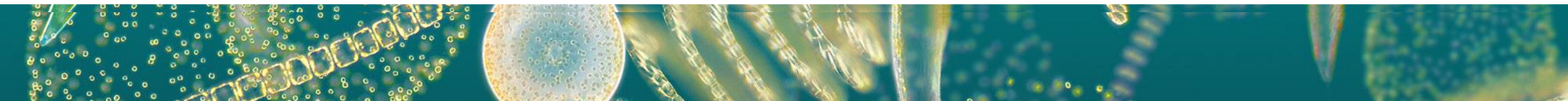
- Serum B₁₂ levels elevated after 12 weeks

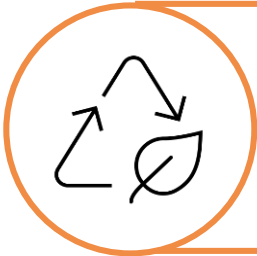




Algal Innovation Centre

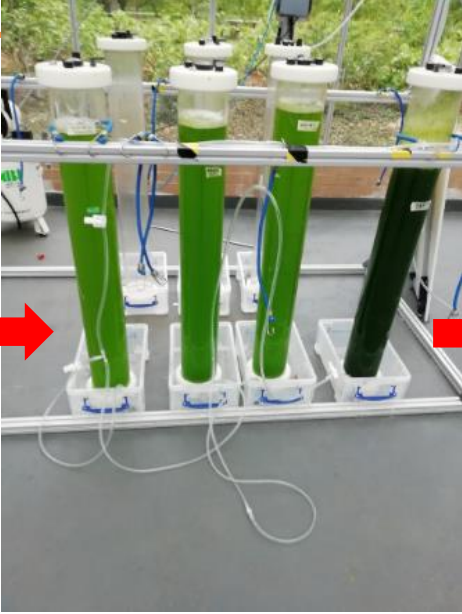
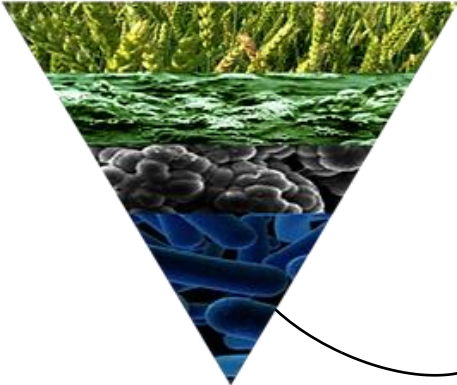
- In Cambridge Botanic Garden
- Test facility to develop pipeline of algal-based solutions
- Autotrophic and Heterotrophic Growth – DEFRA licenced





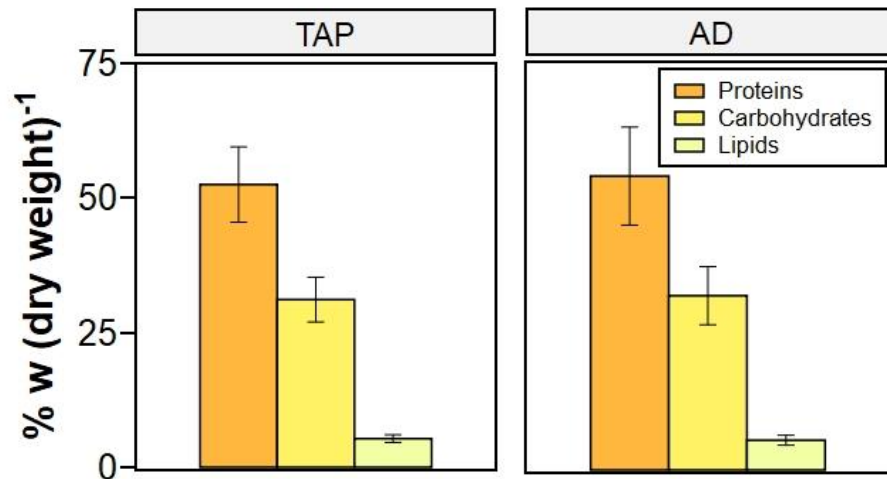
Algae grow well on AD digestate

Anaero Techology

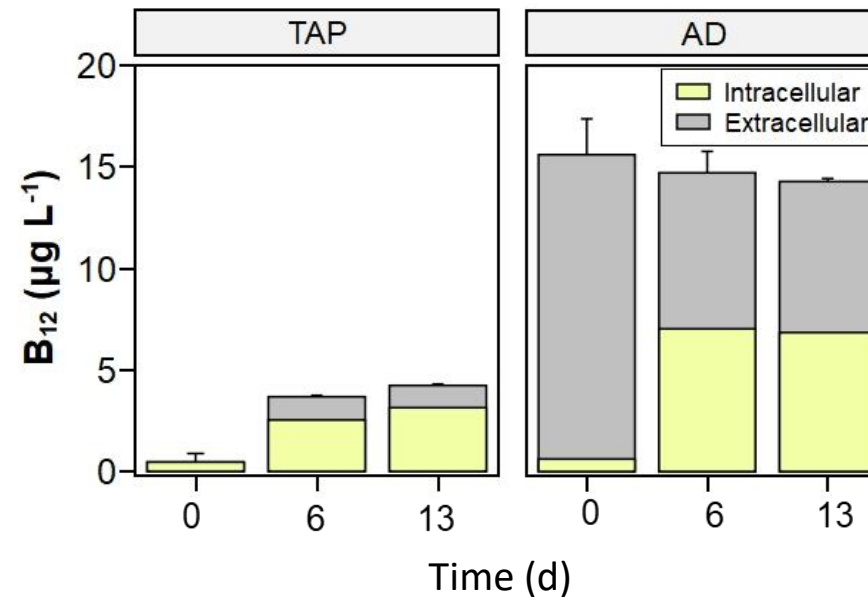




Algal composition grown on digestate



- Protein content: ~50% w/w
- Typical *Chlorella vulgaris* composition, similar in the two media used

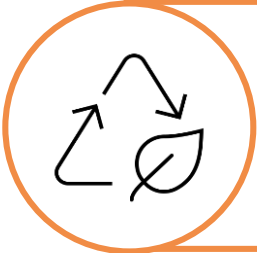


- *Chlorella vulgaris* contains ~25 µg B₁₂/g



Kostas Papadopoulos
Ana Camilla Zenteno-Illanes
Payam Mehrshahi

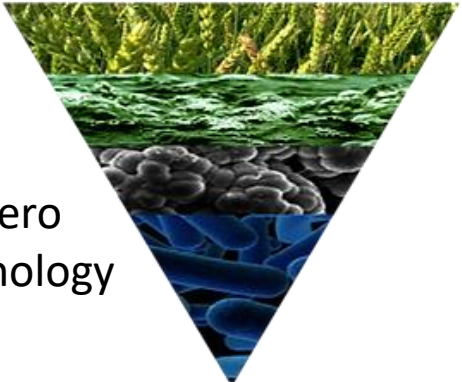
AD = digestate from anaerobic digestion
TAP = standard growth medium



Valorising crop waste with algae

- Using market/vegetable waste in Sub-Saharan Africa

Prof David Cebon

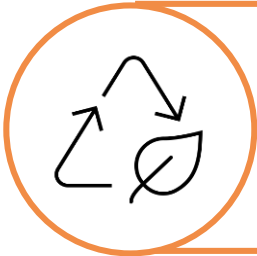


Anaero
Technology



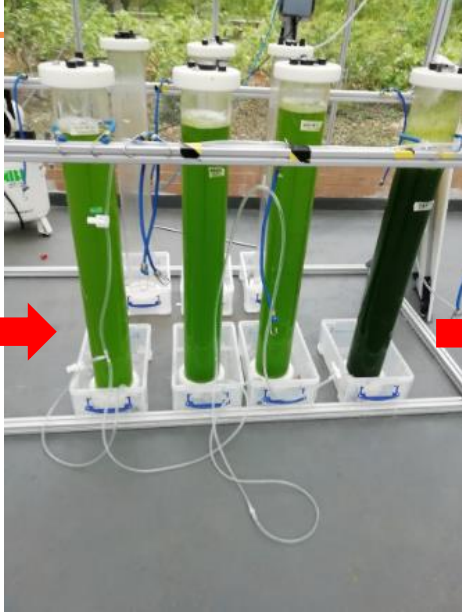
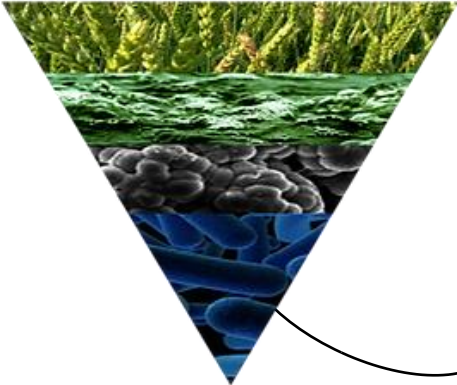
MAKERERE UNIVERSITY

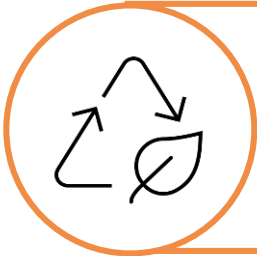
Prof Isa Kabenge
Dr Allan Komakech



Algal biomass supports growth of BSFL

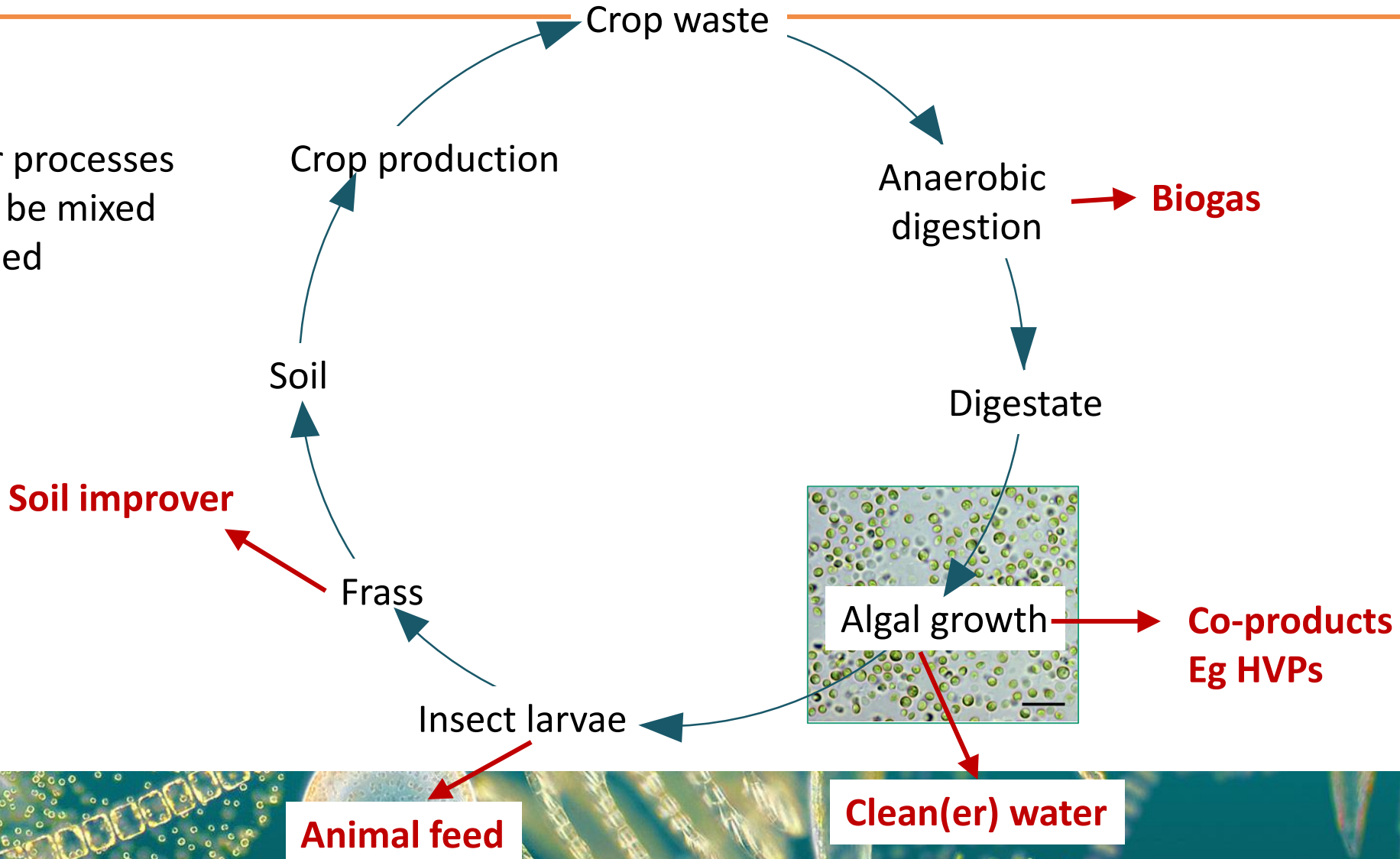
Anaero Techology

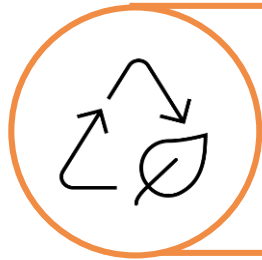




Algae as part of circular process

Modular processes that can be mixed & matched



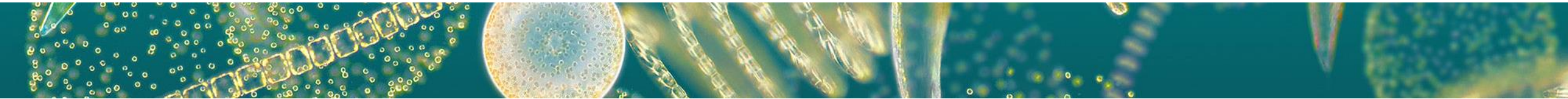


Algae and circular economy in Uganda

Setting up an algal growing research facility in the University Farm (Kabanyoro)

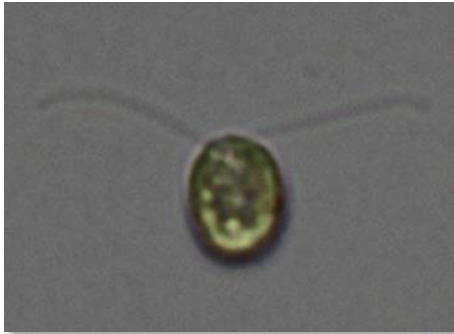
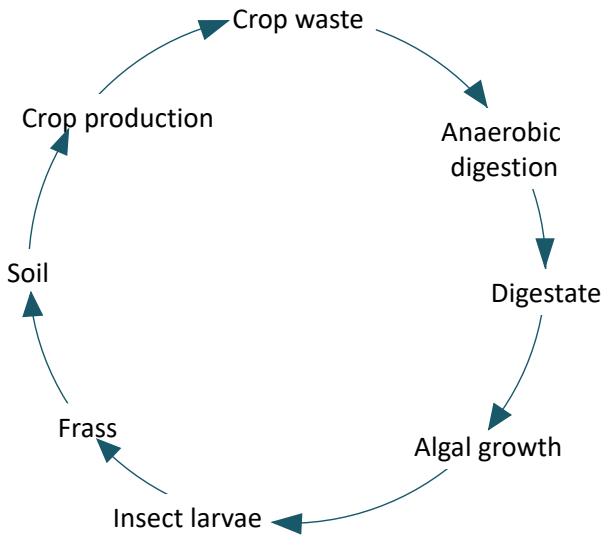


Potential to interlink with other processes studied there and develop sustainable supply chains

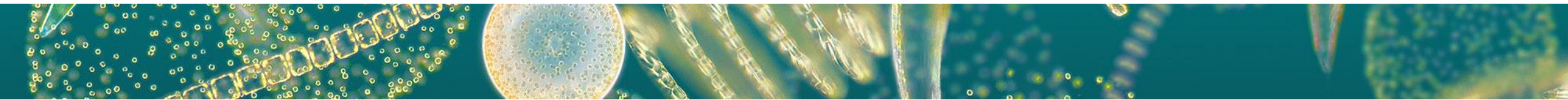




Summary



- Algae offer potential for commercial exploitation for food and feed
- Algae have been shown to provide bioavailable B₁₂
- Algae can be part of circular processes that provide sustainable solutions for food production and waste valorisation





Acknowledgements



**Biotechnology and
Biological Sciences
Research Council**

**THE
ROYAL
SOCIETY**

