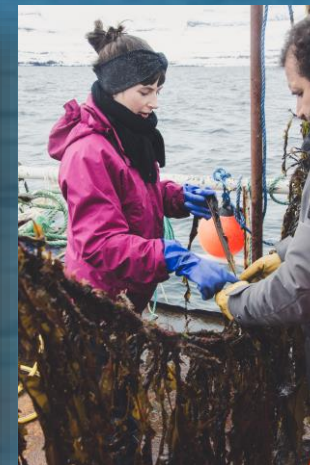


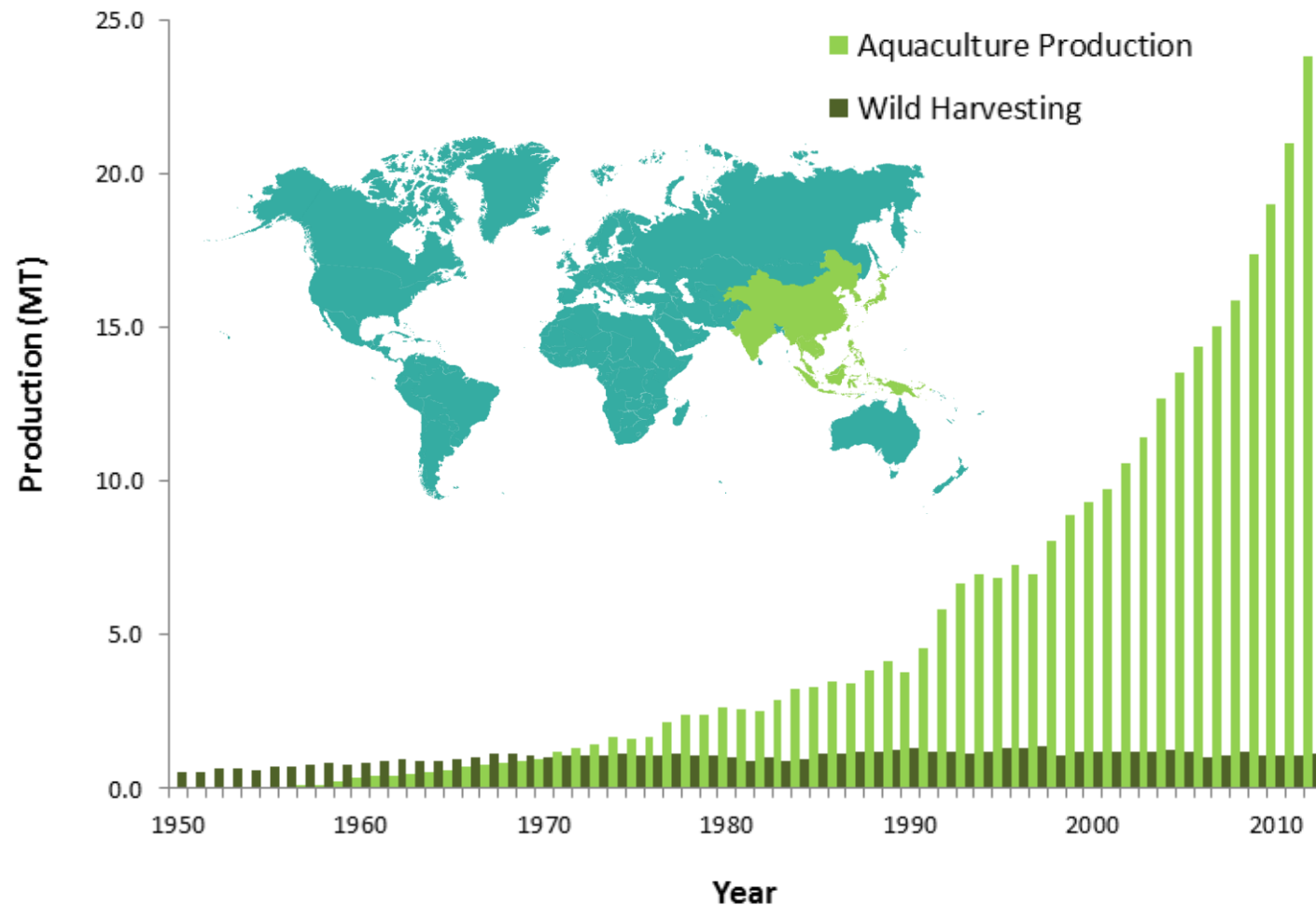


Production of macroalgae in the open ocean – a new protein source?

PhD Urd Grandorf Bak, R&D manager, Ocean Rainforest
Circular Bioeconomy Days
June 27, 2019, Foulum, Denmark



Global seaweed production



US\$ 22 billion
2025

10 years

US\$ 6 billion
2015
30 MT

Ref.

- The global status of seaweed production, trade and utilization, Vol. 124, FAO, 2018
- "Research and Markets", 2018
- Cottier-Cook et al. 2016

Current seaweed applications

Future applications

Hydrocolloids

Food (82 %)

Feed ingredient

Pharmaceuticals

Cosmetics

Biostimulants/ fertilizers

Bio-fuel

Textiles

Bio-plastics

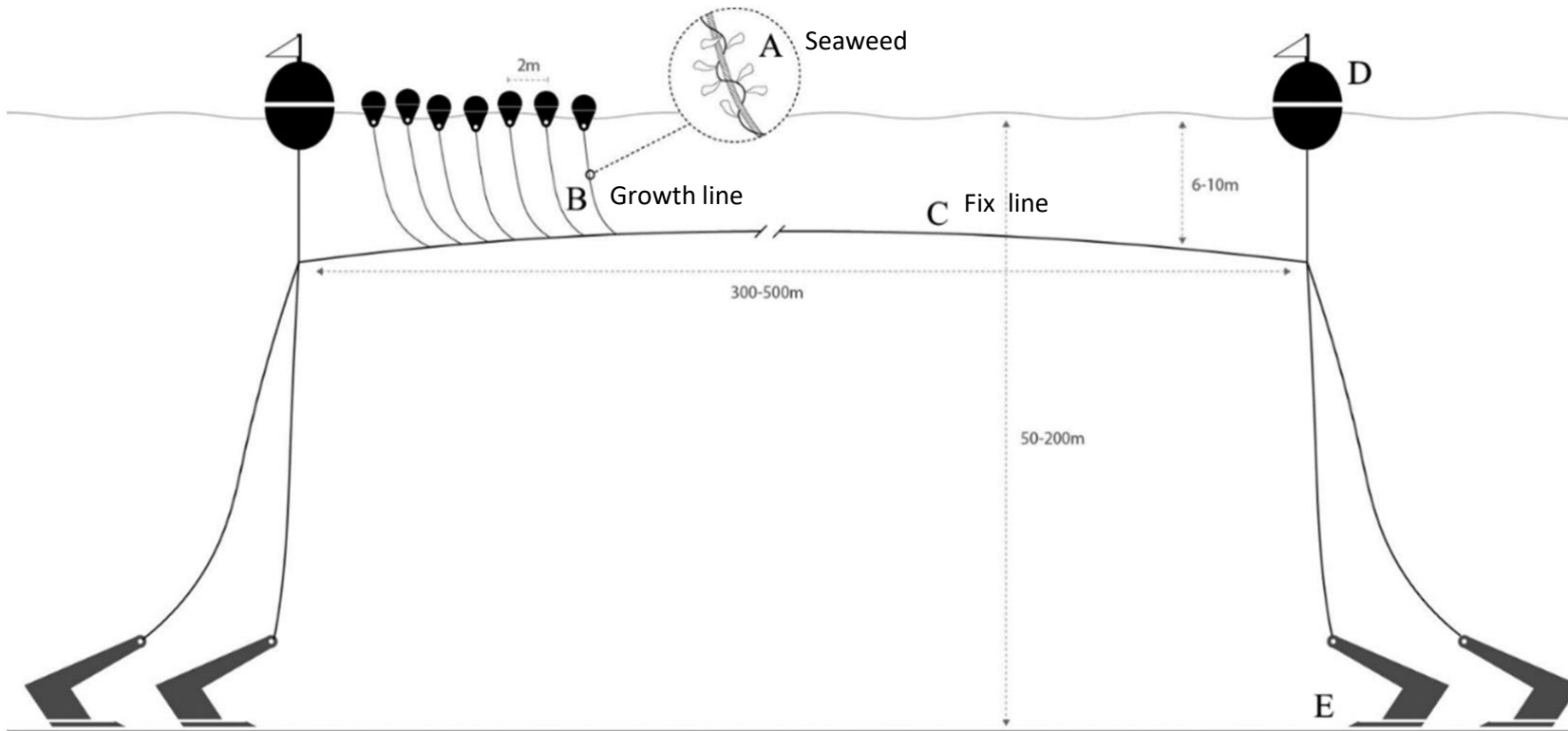




Funningsfjørður, Faroe Islands

- Water depth: 50-70 meters
- Water temperature: 7-11 °C
- Salinity: approx. 35 ‰
- Current: 1-3 knots
- Max. wave height: 8 meters
- Max. wind speeds: 62 m/s

Cultivation structure



MacroAlgal Cultivation Rig = MACR

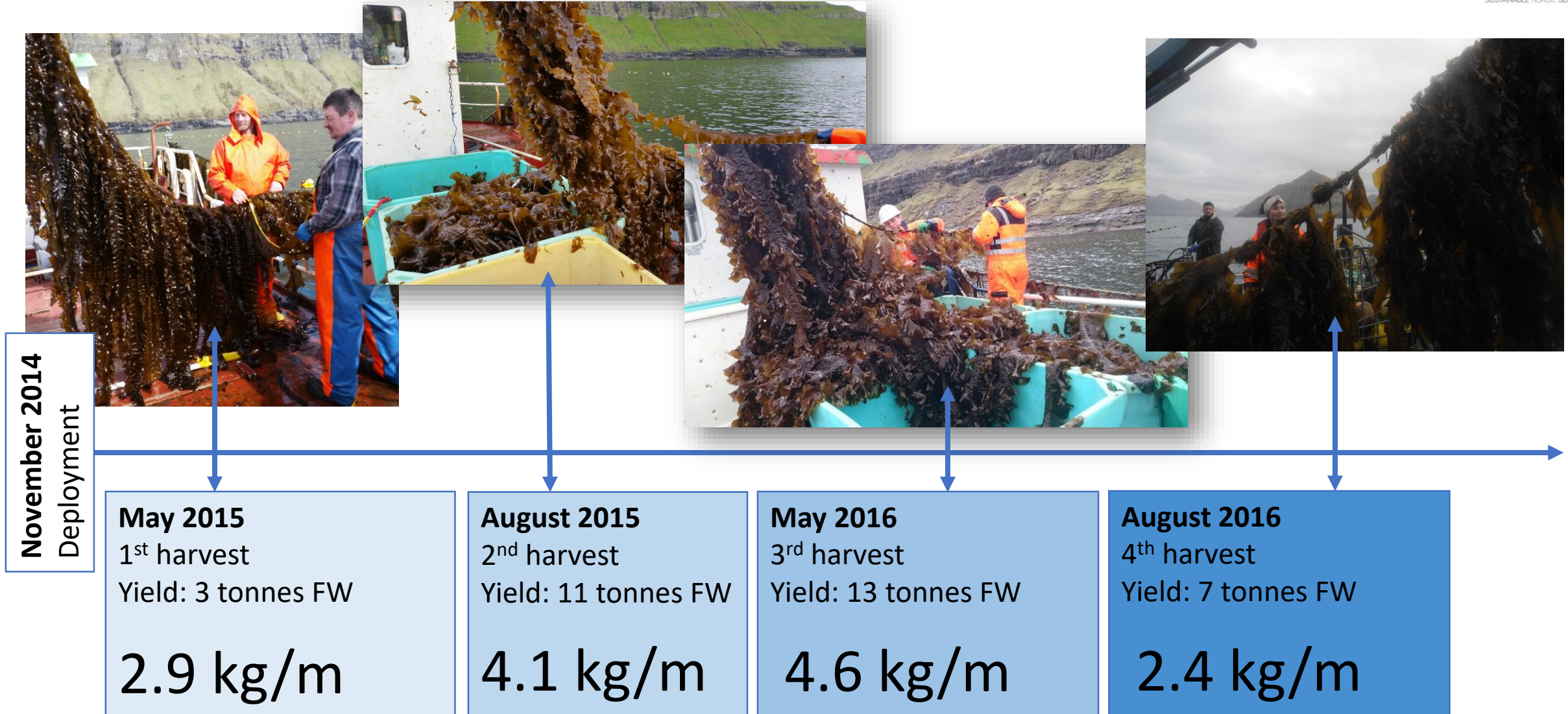
Paper: Bak et al (2018) Production method and cost of commercial-scale offshore cultivation of kelp in the Faroe Islands using multiple partial harvesting.

Harvest method

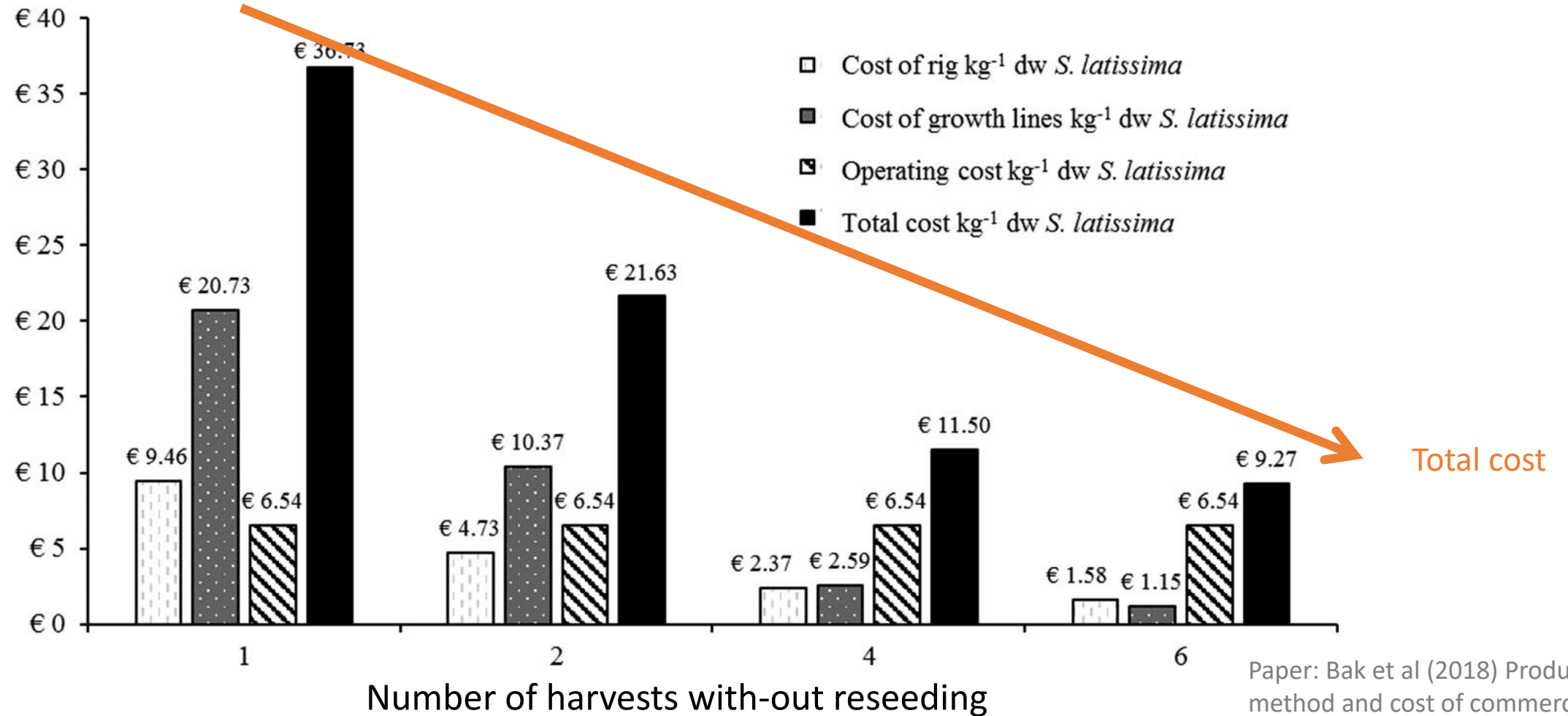


Urd Grandorf Bak, Circular Bioeconomy Days, June 27, 2019, AU Foulum

Yields from multiple partial harvesting



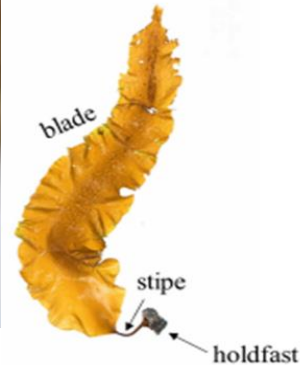
Cost with more harvests



Paper: Bak et al (2018) Production method and cost of commercial-scale offshore cultivation of kelp in the Faroe Islands using multiple partial harvesting.

Analyzing the biochemical composition of cultivated kelp species

Sugar kelp



Winged kelp



Saccharina latissima
n=113

Alaria esculenta
n=63

Laminaria digitata
n=23

Seasonal variation
(Two years, monthly)

Nearshore
sheltered site

Nearshore
exposed site

Lower
(8-10 m depth)

Top
(0-2 m depth)

Lower
(8-10 m depth)

Top
(0-2 m depth)

Result



April 2019

Water (dry matter)
Minerals (ash)

All institutes

Iodine
Inorganic arsenic
Nitrogen
Amino acid composition
D-vitamin + α - and β -carotene



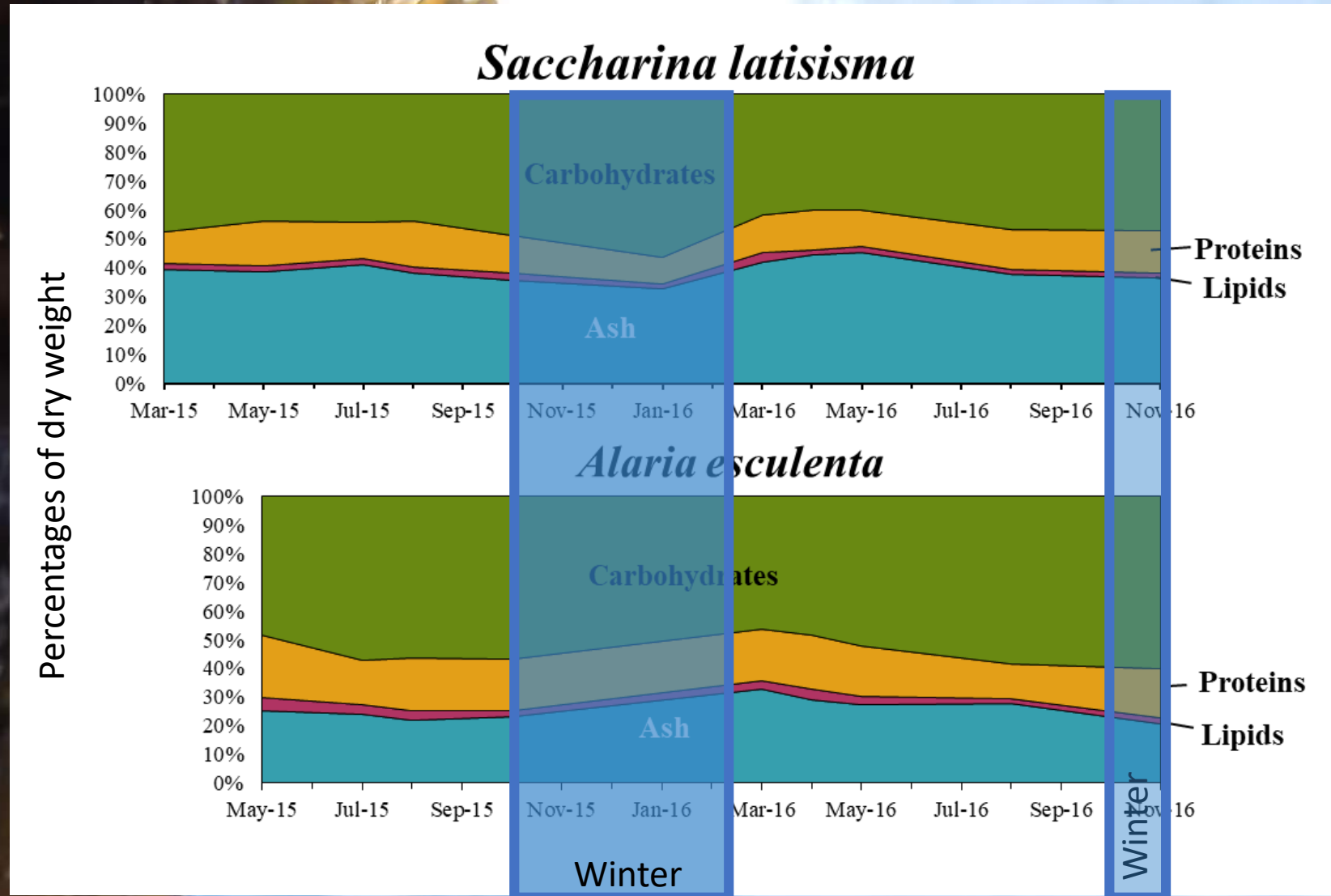
Mercury
Lead
Cadmium
Arsenic
Protein
Lipid
Fatty acid composition
Carbohydrates (calculated)
Monosaccharides
Antioxidants



Phosphorus
Carbon

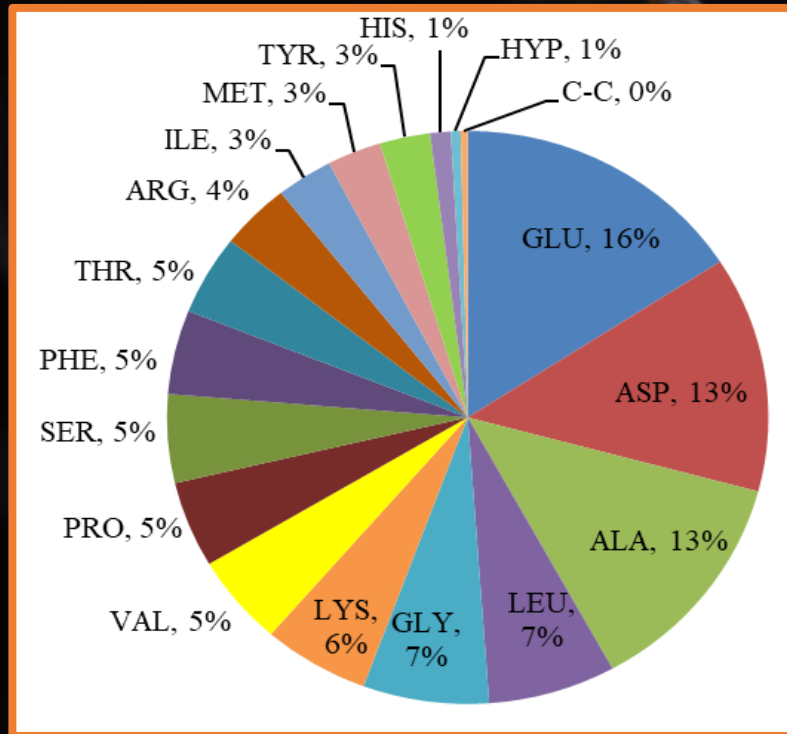


Lack of depth,
site and
seasonal
variation for
lipids, protein,
carbohydrates
and ash

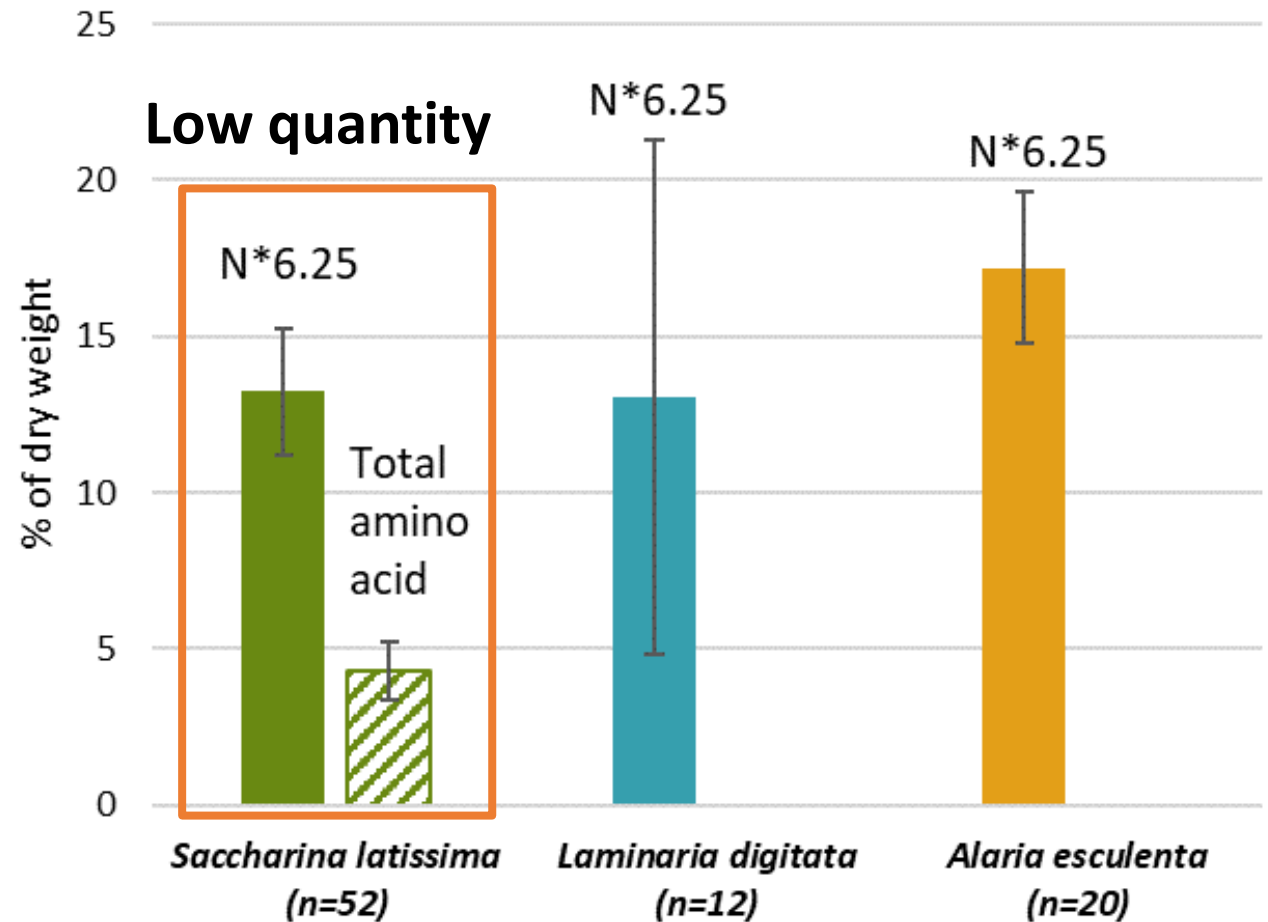


Protein content

High quality (EAA-score)



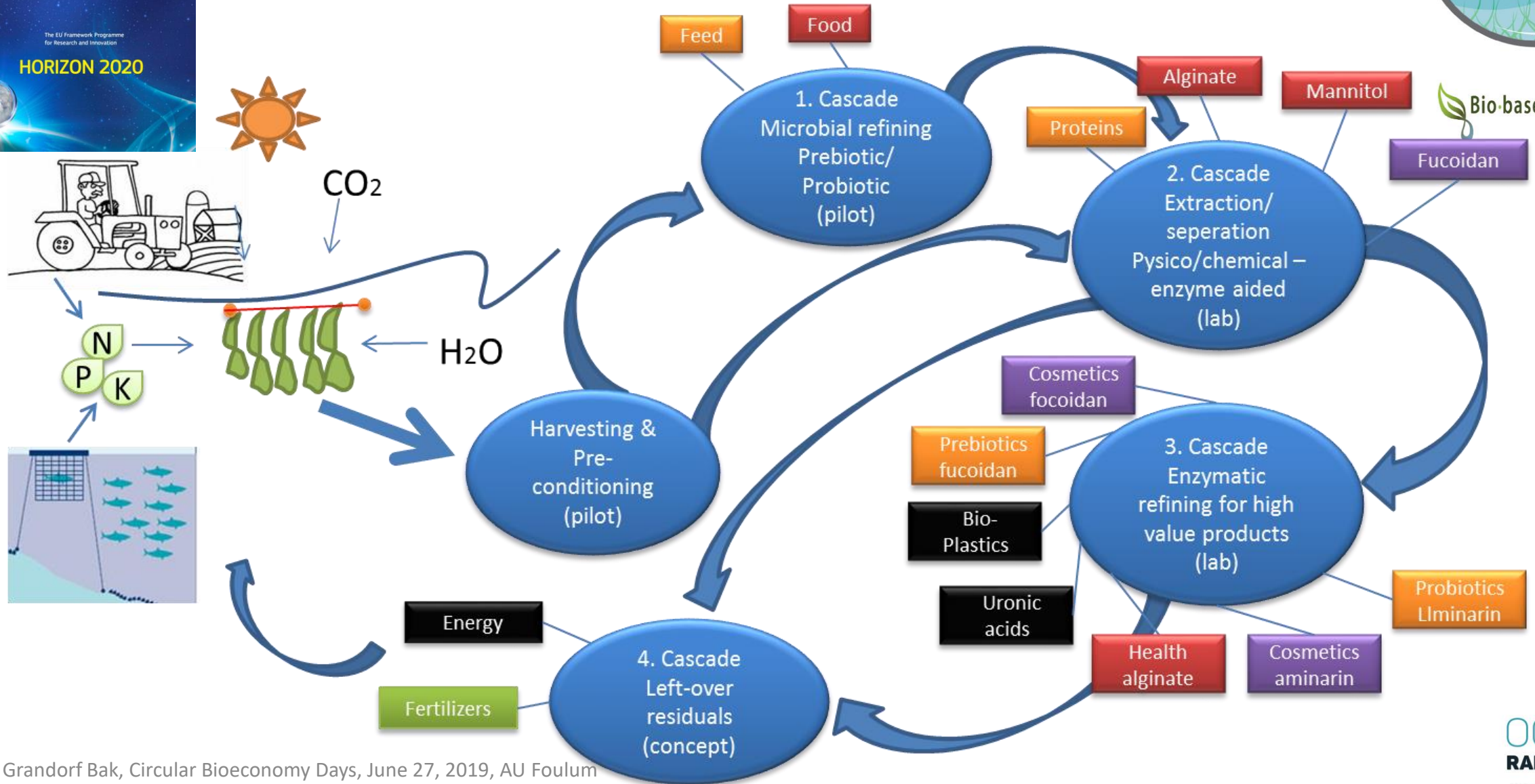
Saccharina latissima



Paper (accepted): Bak et al (2019) The seasonal variation in nitrogen, amino acid, protein and nitrogen-to-protein conversion factors of commercially cultivated Faroese *Saccharina latissima*

MacroCasacde

- The bio refinery approach



Win-win solutions proving environmental benefits



CO₂ uptake

Reduces global heating and acidification of the oceans



Creates ecosystems

Provides shelter, nursery habitat and feeding chamber for fish and other marine animals



Uptake of nutrients (bioremediation)

No use of land, fertilizer or freshwater

Conclusion

1. Cultivated *Saccharina latissima* (kelp) has low quantity of protein (~4%) – but has a good protein quality (EEA-score >100).
2. Multiple partial harvesting is possible offshore in the Faroe Islands, and can reduce cost of production by 75%.
3. Ocean space is available offshore and in exposed sites.
4. Win-win solution proving environmental benefits



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