

PEGASUS

Phycomorph European Guidelines
for a Sustainable Aquaculture of
Seaweeds



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This work has to be cited as:

"M. Barbier, B. Charrier, R. Araujo, S. L. Holdt, B. Jacquemin & C. Rebours "PHYCOMORPH European Guidelines for sustainable aquaculture of seaweeds - PEGASUS" COST Action FA1406, Workshop PEGASUS, 21st September 2018, Brussels."

Responsibility
Resources
Environment
Actions
Stewardship

Need for a paradigm shift in worldview
for global management.

The Anthropocene era

Sustainability
Stability
Resilience

PRODUCED & NARRATED BY LEONARDO DiCAPRIO

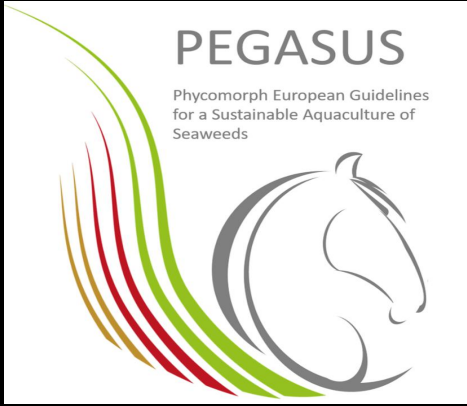
THE 11TH HOUR

TURN MANKIND'S DARKEST HOUR INTO ITS FINEST

Science
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Institute for Science & Ethics

#EGW2018





Ocean science can help us to address impacts from climate change, marine pollution, ocean acidification, the loss of marine species and degradation of marine and coastal environments.

To achieve sustainable development, good science is needed to inform policies and raise the knowledge bar of all stakeholders.

- Vladimir Ryabinin
Executive Secretary, IOC-UNESCO

CHAPTER I - II

SEAWEEDS AS AN OPPORTUNITY FOR HUMAN NEEDS & THEIR ECONOMIC IMPORTANCE



Coordination: Rita Araujo, EC-JRC &
Céline Rebours, Møreforsking Ålsund AS

SEAWEEDS, Important ecological role

- Support complex food web in coastal system
- Defence role
- Carbon sequestration
- Removal of dissolved nutrient (N & P uptake)
- Removal of ions (petrol, dyes)



SEAWEEDS, a source for human needs



HEALTH & HUMAN WELL-BEING (Cosmetics, pharmaceuticals, nutraceuticals,
FOOD & food processing/additive (> 70% of seaweed used for food).

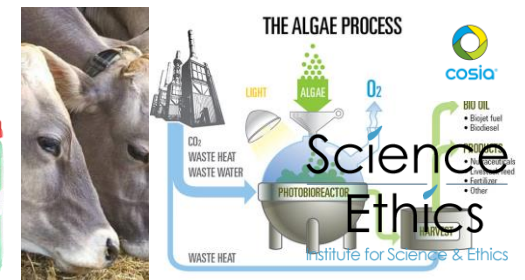
In Europe, main markets : hydrocolloids)

AGRICULTURE (animal feed, plant growth, CO₂ uptake)

BIOFUEL

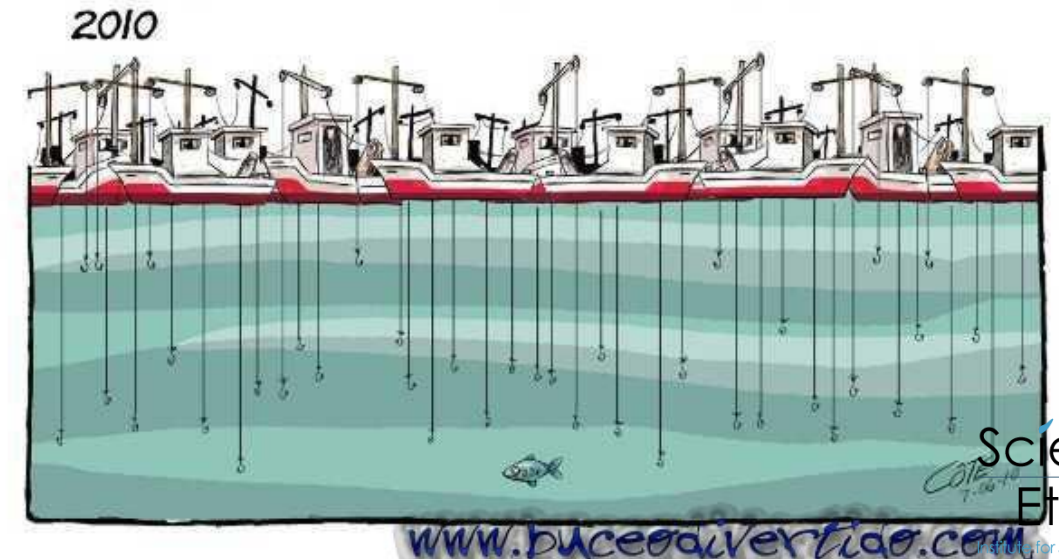
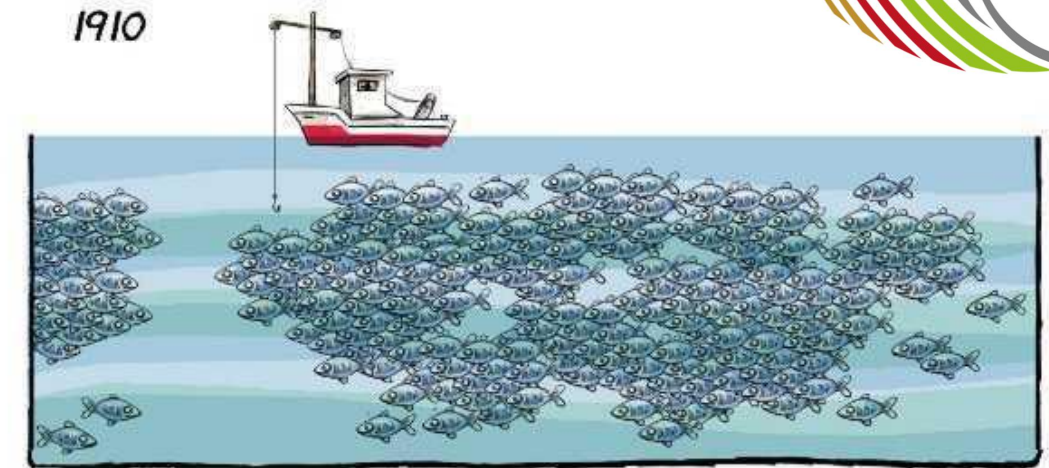
POLYMER (bioplastics)

ECOSYSTEM MANAGEMENT (bioindicator, wastewater treatment/ heavy metal removal)





FOOD SECURITY PRESSING GLOBAL CHALLENGE



SUSTAINABLE DEVELOPMENT GOAL 14

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

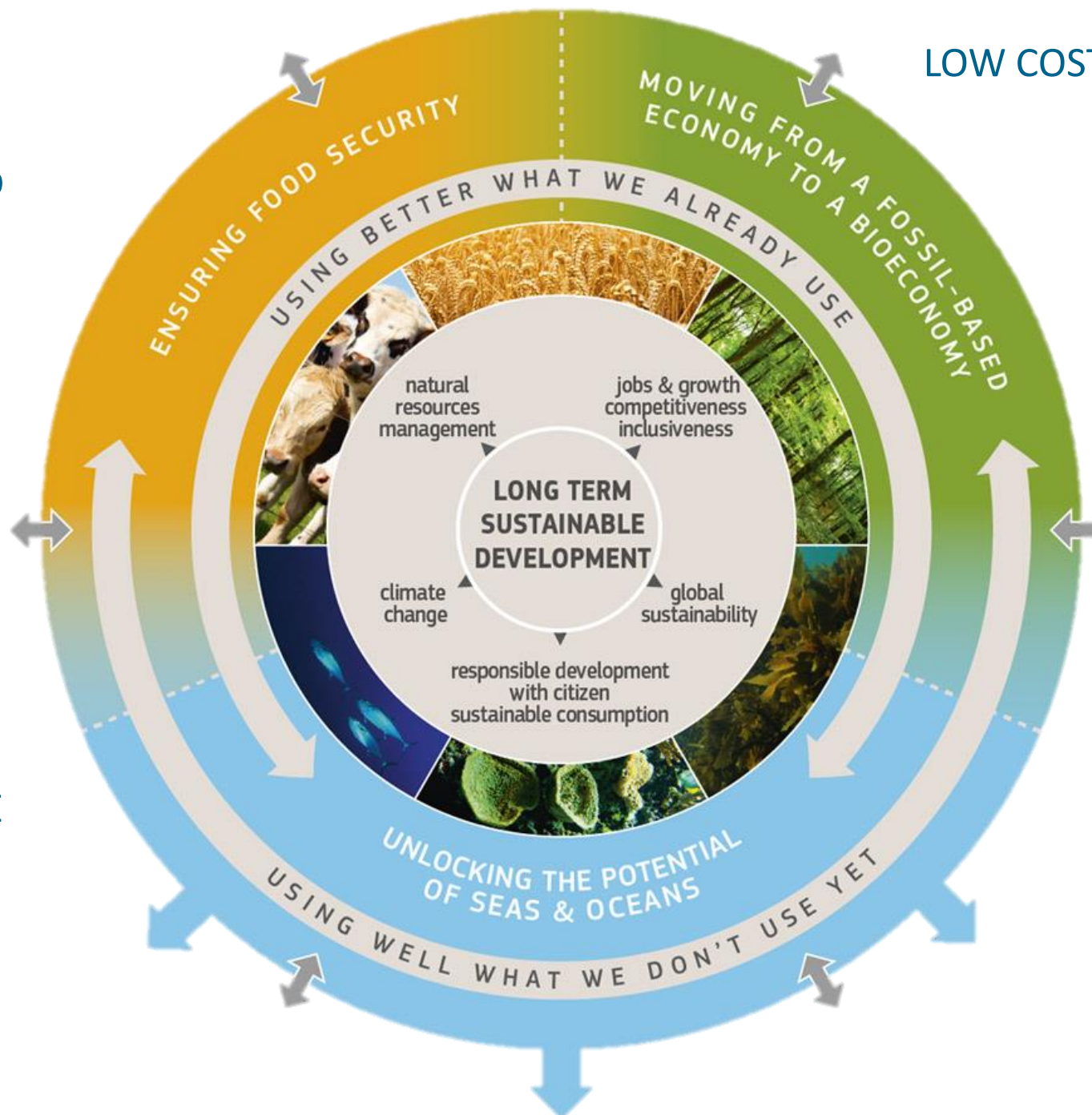


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SUSTAINABLE
SUPPLY OF FOOD

CLIMATE CHANGE
MITIGATION



LOW COST ENERGY

CREATING JOBS

INNOVATION

PEGASUS

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for a Sustainable Aquaculture of
Seaweeds



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How to obtain economic and environmental sustainability and competitiveness of seaweeds primary production and processing industries?



A sustainable management of resources is essential for establishing the balance between **economic growth** and **healthy ecosystem** supported by **policymakers**

CHAPTER III - IV

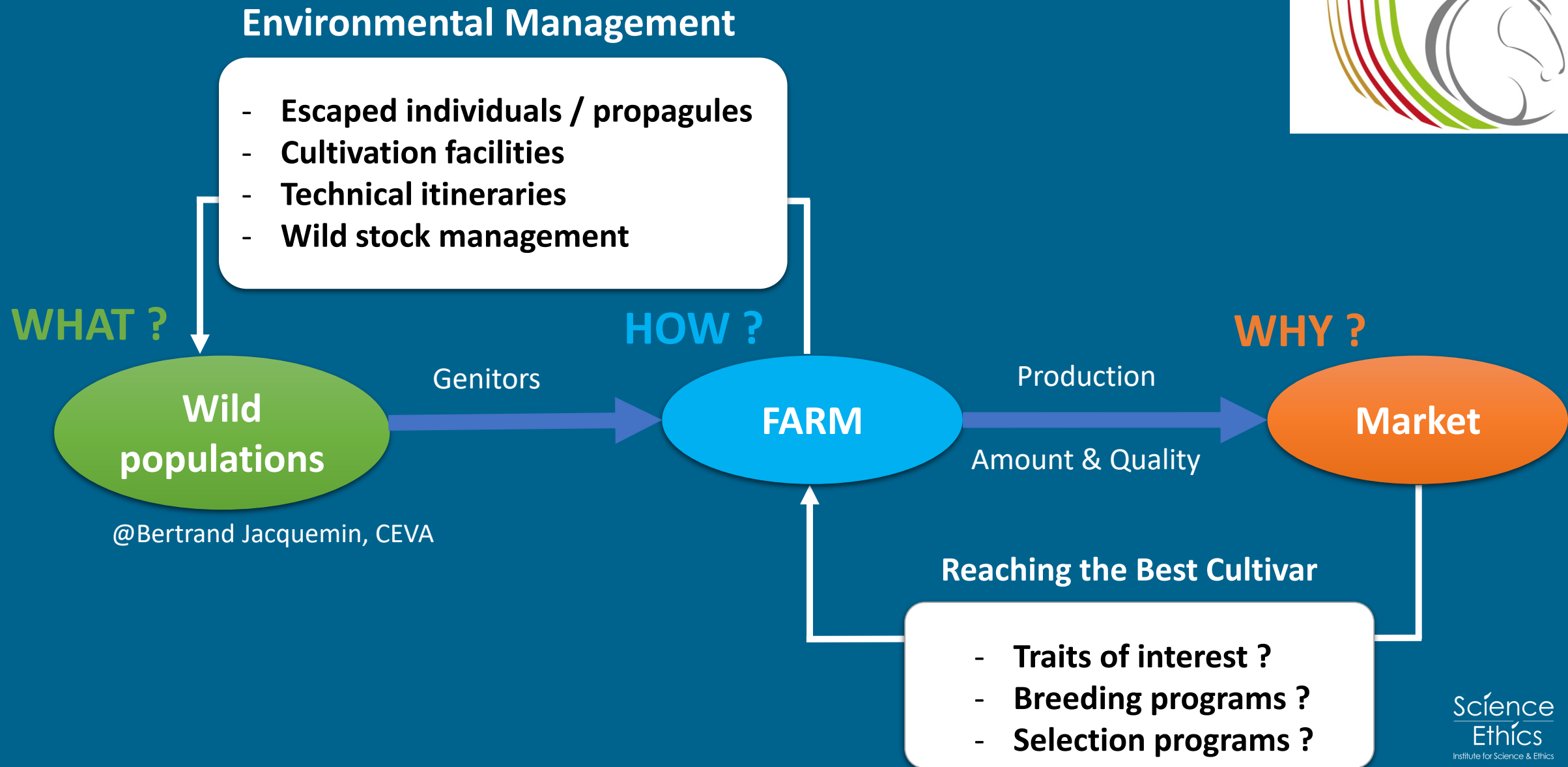
SEAWEEDS PRODUCTION – CULTIVATION

STATES OF THE ART & CHALLENGES



Coordination: Bertrand Jacquemin, CEVA
& Bénédicte Charrier, CNRS

FOR A SUSTAINABLE SEAWEED AQUACULTURE



CHALLENGES - DOMESTICATION: SOURCING FOR FARMERS

PEGASUS

Phycormorph European Guidelines
for a Sustainable Aquaculture of
Seaweeds



Non-indigenous species

➤ Unadapted to the local environment

➤ Invasive species



C. fragile

G. vermiculophylla



U. pinnatifida



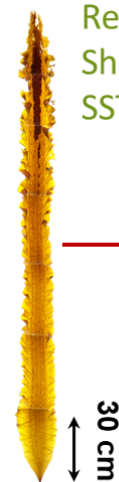
➤ Introduction of annexed organisms :

- grazers
- diseases/parasites
- epiphytes

Indigenous species : Local vs distant populations

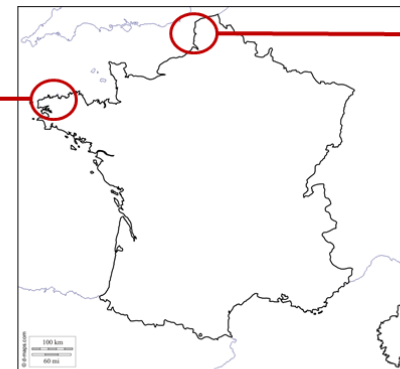
Local adaptation of populations ?

Example : *Saccharina latissima*



Repro: Oct to March
Sheltered habitat
SST from 10°C to 19°C

30 cm

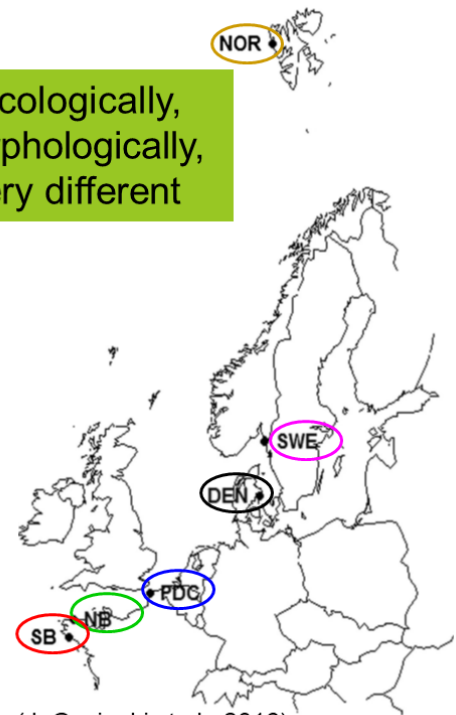


30 cm

Repro: Dec-Jan
Exposed habitat
SST from 4°C to 20°C

Populations are Ecologically,
phenologically, morphologically,
and genetically very different

(B. Jacquemin et al., 2016)



(J. Guzinski et al., 2016)

Cultivated strains & cultivation techniques must be adapted to the local environment of the farm

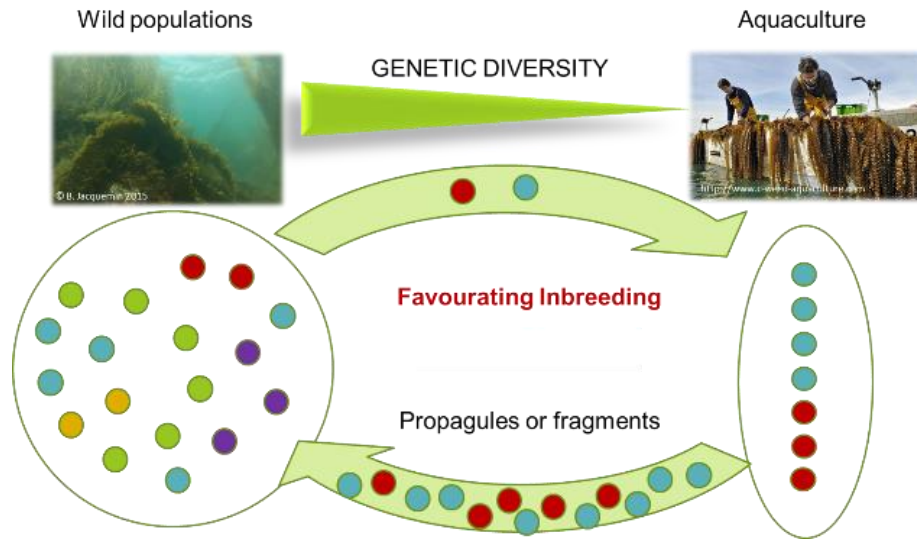


REACHING THE BEST CULTIVAR

Breeding and selection programs

Using local populations for the sourcing

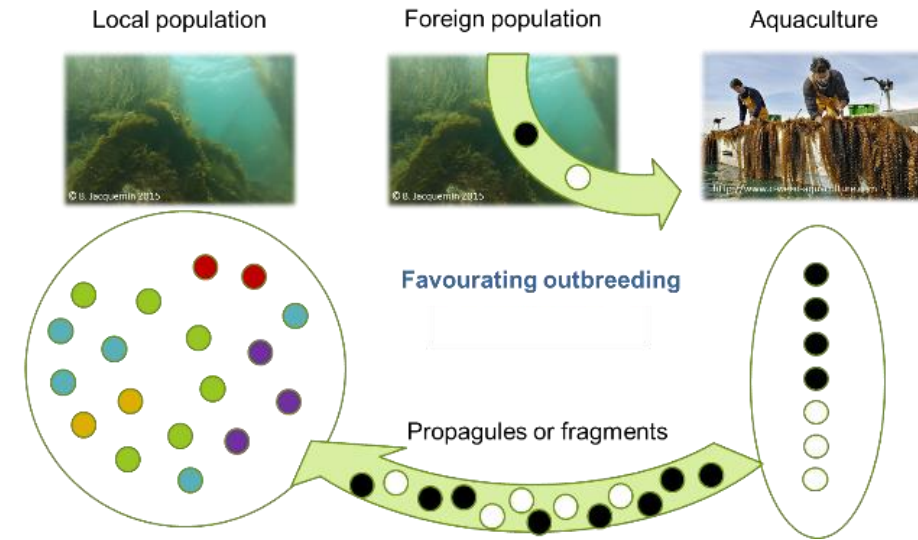
A small part of the local genetic diversity is widely reproduced



@Bertrand Jacquemin,CEVA

Using distant populations for the sourcing

Foreign genetic assemblages are widely reproduced



LOSS OF LOCAL GENETIC DIVERSITY



OBTAIN THE BEST CULTIVAR



- Local population
- biochemical composition sp. or flavor per unit time
- Distance, waves, Current depth, T, S, Nut.
- Market choice
- effort & cost
- Choice from wild
- Location farm
- Local Genetic diversity
- Climate change
- Balance in-outbreeding
- Seasonnability
- Epiphytes

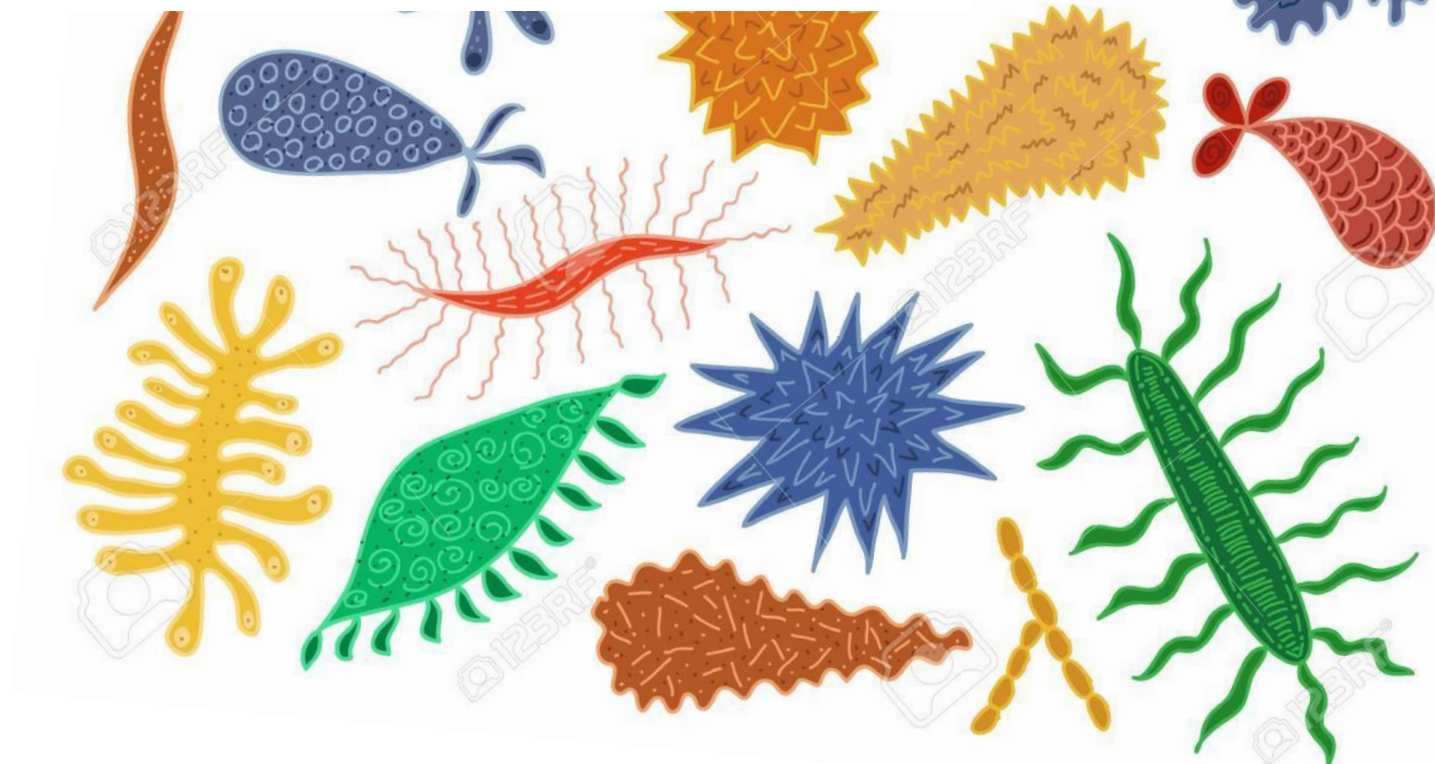
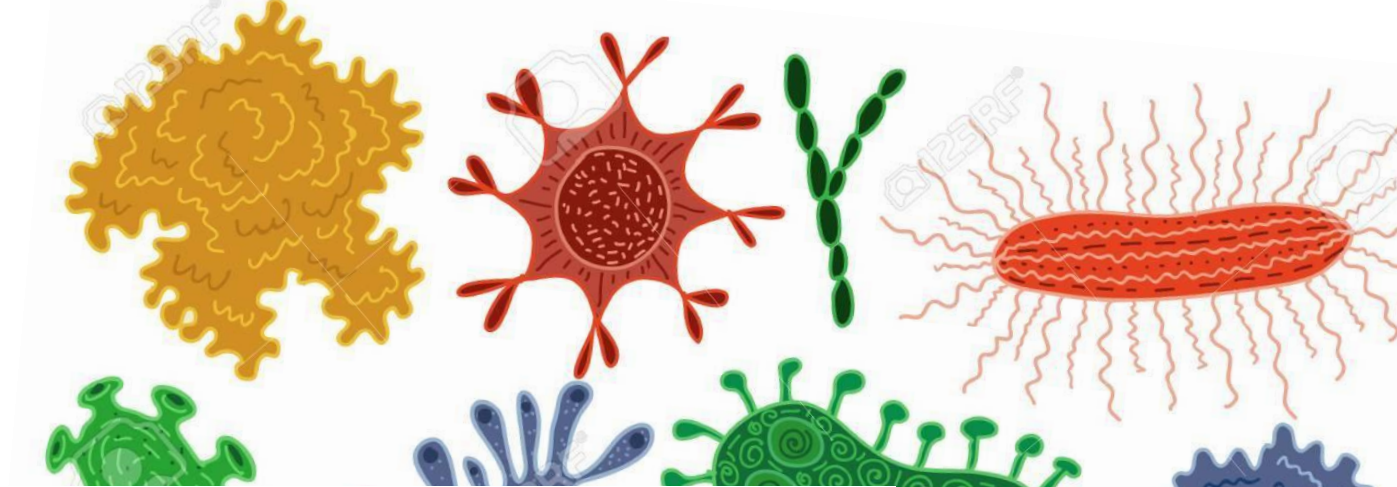


PHYCOMORPH
Advancing Knowledge Of Seaweed
Growth And Development
COAST Action FA1406 (2015-2019)

@Michèle Barbier

DISEASE AND PESTS

Treatment against pathogens are almost unexplored



STORAGE OF STRAINS

Back up of the cultivated strains
Collection of traits of interest
Free sourcing from the wild stock

Vegetative cultivation



Cryopreservation



PRODUCTION TECHNIQUES

Controlled conditions
Mechanization and automation,
Reduction in transportation times and volumes

At sea



Open water
Seaweed carrier



EU project At-sea, 2015

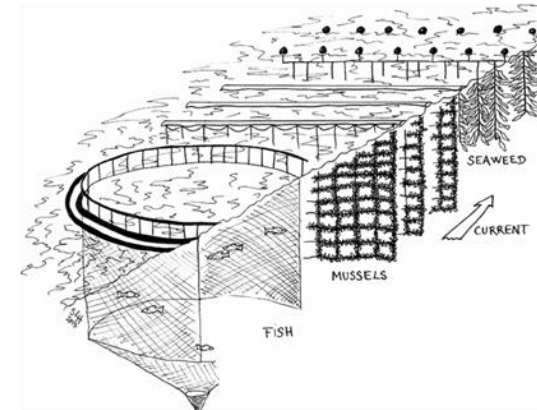


Benthic production
2D textile substrate

EU project SEABIOPLAS



Land-based



IMTA
Combination of
different aquaculture
productions (trophic
relationship, reduce
environmental
impact, diverse
markets.

PRODUCT PROCEEDING

Only few studies on preservation techniques & their impact on the valorization of valuable compounds

Drying

Unknown consequences on the product's nutritional value and extraction yields of valuable compounds

Enzymatic treatments can improve the extraction yield of bioactive compounds from seaweed

European regulation about both fermentation (regulation (EC) No 852/2004 on the hygiene of foodstuffs) and enzymes uses (regulation (EC) No 1332/2008 on food enzymes).

Freezing

Little efforts were committed to optimize the quality of frozen seaweeds

PRELIMINARY RECOMMENDATIONS



What is cultivated?

- ONLY cultivate indigenous/native species
- ONLY collect genitors from local populations
- Select traits locally adapted
- Build local strains collections
- Develop tools to ensure traceability of the strains/traits
- Develop Breeding programs under controlled conditions
- Support Basic/Applied Research: Knowledge on biology of seaweeds: Growth, reproduction, physiology, metabolism, pathology, life cycle, etc

SOMATIC
HYBRIDIZATION

GENETIC
TRANSFORMATION

NOT RECOMMENDED

PRELIMINARY RECOMMENDATIONS

How is it cultivated?

- Non-intensive strategies
- More knowledge on pest and diseases outbreaks management
- Prevent any reproduction events and/or dispersal from farms to the wild populations
- Best practices for standardized approach
 - production scalability
 - higher and consistent quality
 - traceability of origin and predictable production calendars.

PRELIMINARY RECOMMENDATIONS

Governance / Technical structures



Local level : Define the geographical limits of the “local sourcing” for each farm and update the management plans for coastal areas.

Regional level: Implement Technical Centres of Reference to help and/or supply producers

National level: Implement Certification Centres to control the origin of the cultivated strains and develop Training centres/courses for seaweed producers

CHAPTER V

MARKET ECONOMY - LEGISLATION



Coordination: Rita Araujo, EC-JRC

RELATED SEAWEEDS AQUACULTURE LEGISLATION



Directive/Political initiative	Challenges
Habitats directive on the conservation of natural habitats and of wild fauna and flora	Aquaculture development should be compatible with natural habitats and biodiversity protection
Marine Strategy Framework Directive = framework for community action in the field of marine environmental policy	Aquaculture development should not negatively affect biodiversity and intertidal ecosystems, should not contribute to the introduction of invasive species or to the increase of eutrophication in marine waters (coastal areas and open sea).
Water Framework Directive establishing a framework for the protection and enhancement of good status of inland surface, transitional, coastal and ground water	Aquaculture development should not negatively affect biodiversity of macrophytes and phytobenthos or of eutrophication in coastal waters
Maritime Spatial Planning Directive establishing a framework for the planning of multiple uses of the maritime and coastal areas	The development of open-sea aquaculture implies a good management of space use coordinated with other maritime activities
Common Fisheries Policy setting the rules for the management of fishing fleets while assuring the conservation of fish stocks	Currently the Multiannual national strategic plans for the development of sustainable aquaculture do not refer seaweed aquaculture among the main species cultivated per volume

RELATED SEAWEEDS AQUACULTURE LEGISLATION



Directive/Political initiative	Challenges
<p>Alien Species Regulation on the prevention and management of the introduction and spread of invasive alien species</p>	<p>The list of alien species of Union concern currently does not include any marine species</p>
<p>Regulation 708/2007 concerning the use of alien and locally absent species in aquaculture</p>	<p>This regulation is not entirely applied to the alien and non-local species listed in Annex IV of the regulation. No seaweeds are listed in Annex IV. Recommend risk assessment if already established in coast lines.</p>
<p>Regulation 511/2014 on compliance measures for users from the Nagoya Protocol</p>	<p>Unclear situation regarding cultivated genera and the protection of genetic resources. Does it apply within national jurisdiction. Area beyond National Jurisdiction</p>
<p>Regulation 2015/2283 on novel foods</p>	<p>Novel food should not be placed on the market or used as food for human consumption unless it is included in the Union list of novel food authorized to be marked within the Union. Up to now, regarding seaweeds, the products included in the list are Ecklonia cava phlorotannins, and fucoidan extract from Fucus vesiculosus and Undaria pinnatifida</p>
<p>EU recommendation 2018/464 on the monitoring of metals and iodine in seaweed, halophytes and products based on seaweed</p>	<p>Although a list of seaweed species authorized as food is currently available, it is not clear if some species (e.g. Codium sp.) listed as target to be monitored are authorized as food within the Union. The arsenic level detection from seaweeds is of concern.</p>

NATIONAL AQUACULTURE REGULATION & STRATEGIC PLANS

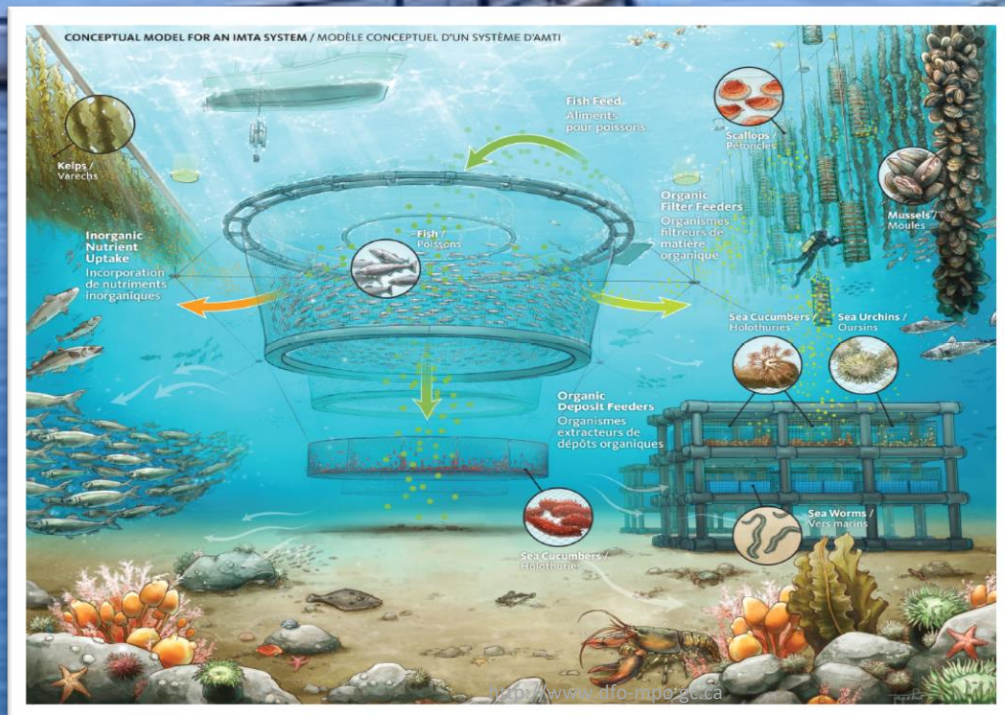
SEAWEEDS SPECIFIC REGULATION
CURRENT SITUATION
CHALLENGES

MORE COUNTRIES ?



MARITIME SPACE USAGE

Need regulatory
framework
Acceptability by the
society



PRELIMINARY RECOMMENDATIONS

SUSTAINABILITY	Marine Diversity	<p>Update the Regulation EU 1143/2014 to include marine invasive species</p> <p>Establish a list of alien species of economical interest in Europe and assess its risk for the environment if necessary</p>
	Environment	<p>Common Fisheries Policy should consider seaweeds aquaculture, Coordination of legislation/licensing,</p> <p>Establishment of a clear regulation for IMTA system</p>
COMMERCE	Importation	Imported seaweeds need to comply with the EU or national legislations on seaweed as food, food supplement or feed.
	Licencing	<p>Transparent and easy process</p> <p>Standardization for production and distribution at European scale</p>

COMMERCIALIZATION / FOOD MARKET – CULTURAL DIMENSION



CHAPTER VI

on

FOOD SAFETY



Coordination: Susan L. Holdt, DTU

Porphyra nutrition indication

Proteins (47%)

Low Na/K ratio (salt replacing)

Low Lipid (but 50% omega 3)

Polysaccharides 35-60%

Dietary Fibers

Minerals: Na, K, P, Ca, Mg, I, Fe

Vit A, B1, B2, B6, B12, C, D, E

Organic arsenic

Iodine (for other species)



Organic
certification
EC 710/2009

Former Novel Food Regulation (EC) No. 258/97
Recalled in Regulation (EU) 2015/2283

Vitamins
Food additives



DIRECTIVE 2002/32/EC

Heavy metal
legislation
EC 629/2008, EC1881/2006

NOVEL FOOD REGULATION
EC 2018/460

Implementation administrative &
Scientific requirement
EC 2017/2469

ONLINE CATALOGUE of Novel food

Labeling
EC 1168/2011

UNION LIST OF NOVEL FOOD
EC 2017/2470

Reaurement for
application of NFR
EC 2018/460

Beneficial
effect
EC 1924/2006



FOOD SAFETY REGULATION
EC 178/2002

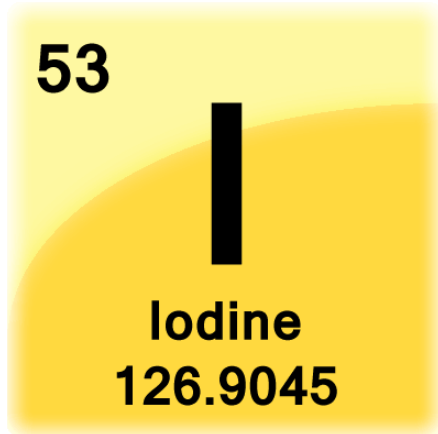
POTENTIAL FOOD

LEGISLATION
AUTHORIZATION
NUTRITION - SAFETY CONSUMERS

European Food Safety Agency

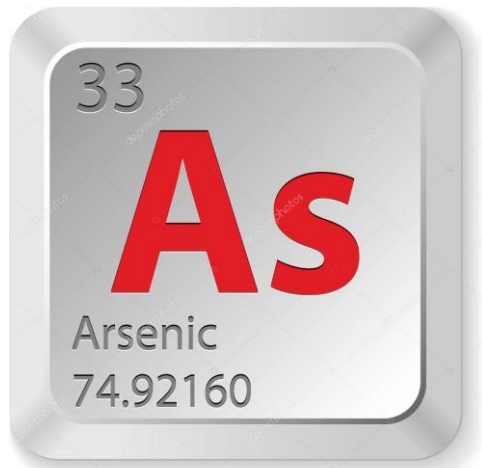


CHALLENGES FOR THE INDUSTRY



Unclear signals/regulation on the threshold values of different contaminants in seaweeds as food

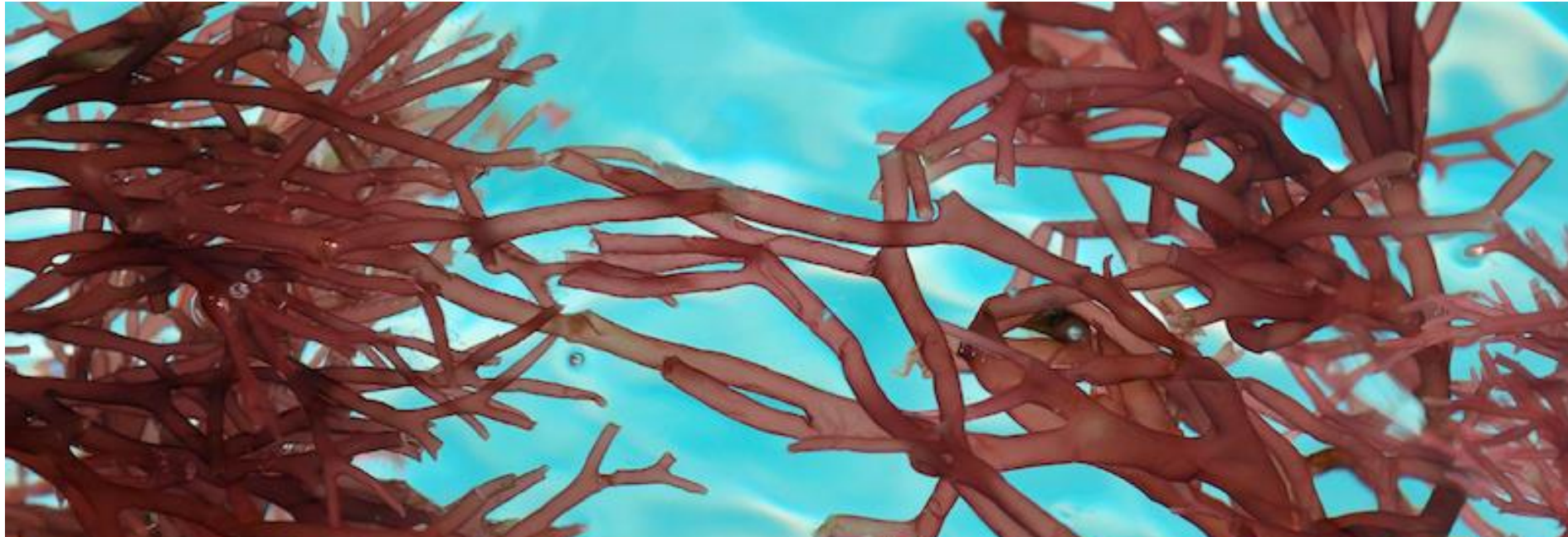
Needs alignment of the legislation on contaminants and the “novel food” catalogue



non Homogenised threshold values in the new legislation of contaminant in seaweed for food (should be stated as dry weight)



CHALLENGES FOR THE INDUSTRY



- Disperse certification bodies in diff. countries for organic certification (cultivation/ harvest/ products)
- Impacts of post-harvest handling on quality and quality of the stability of seaweed
 - nutrient content
 - organoleptic properties
 - Microbiology





PRELIMINARY RECOMMENDATIONS

The European Commission novel food list needs to be updated including species already on the market.

For the European Commission online novel food catalogue the following should be done, avoiding mix novel and non-novel food:

- Only list the seaweeds that are novel food
- If/when seaweeds are categorized as "novel food" list
- An official list of all seaweeds should be completed and made available, to facilitate

**Make one list,
Make it visible**

New compounds extracted from seaweed should be checked if eligible as food ingredient according to the Commission Implementing Regulation (EU) 2017/2470 or undergo application for acceptance.

PRELIMINARY RECOMMENDATIONS



CONTAMINANTS

- Update the Arsenic threshold level in legislation (harmful inorganic)
- Need for standards and definitions of chemical compound classes, activities, traceability, standards of methods and claim
- Homogenisation of organic certification across EU
- Definition of Best storage procedures
- Industrial classification codes defined by the seaweed experts & industry and put forward to the authorities for food control

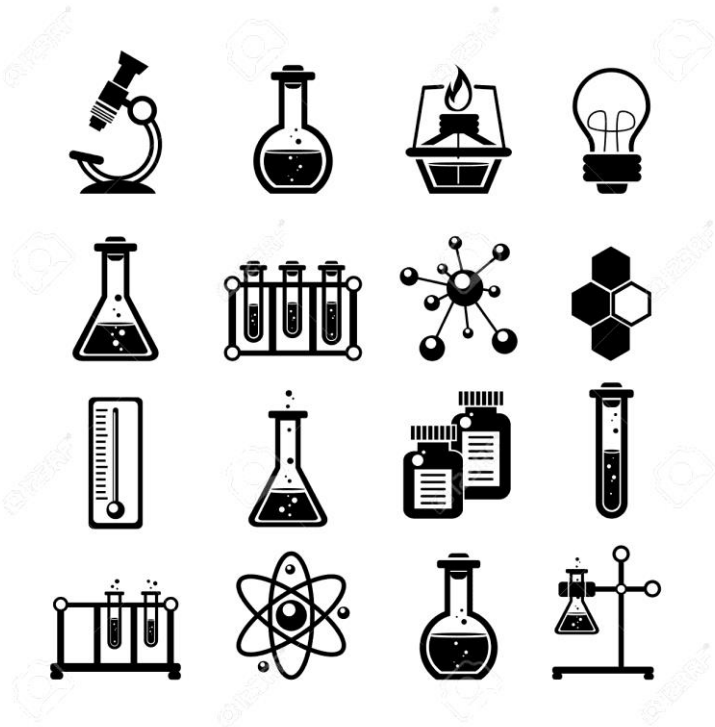
PRELIMINARY RECOMMENDATIONS



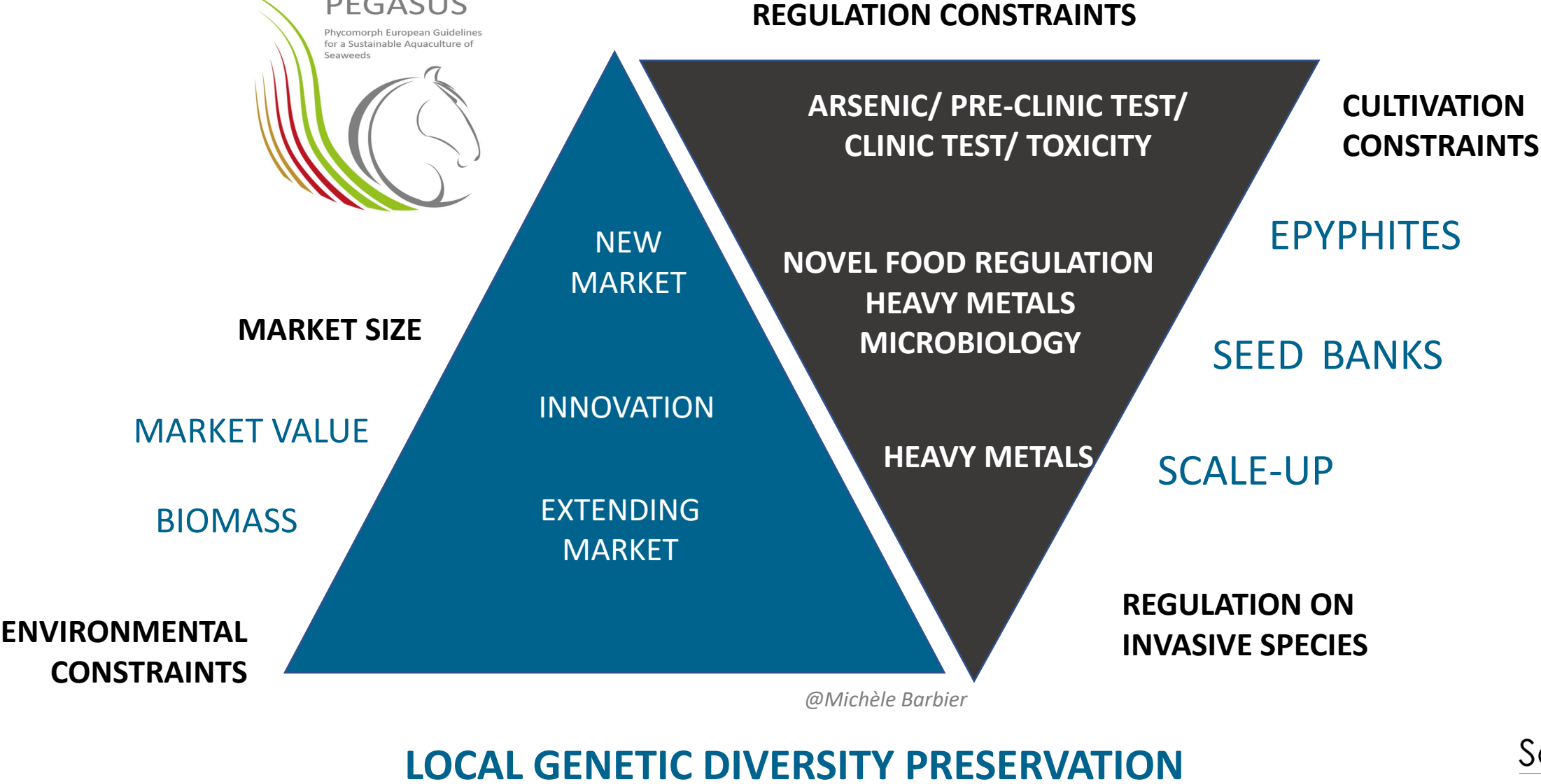
- Create a vocabulary to describe the different flavors of seaweed
- Implement sensory evaluation panels/consumer panels

More knowledge is needed

- on speciation/chemical form and uptake of seaweed iodine and how to reduce iodine, new methods for the detection of the different chemical forms
- on standardization of identification methodologies, effects of preservation treatments on the biomass
- risk- benefits analyses on health.
- Best storage procedures
- Bioprospecting



BOTTLENECKS



@Michèle Barbier


KEY MESSAGES

ADAPT, UPDATE AND UPGRADE EUROPEAN LEGISLATIONS

IMPLEMENT TRANSPARENT AND CLEAR GOVERNANCE

PROVIDE ACCESS

REGULATIONS



PRESERVE THE LOCAL GENETIC DIVERSITY

USE LOCAL – THINK GLOBAL

NO INTENSIVE CULTIVATION

SHARE EXPERTISE

HOMOGENIZE REGULATIONS &
UPGRADE LEGISLATIONS

ASSESS BENEFITS- RISKS

EDUCATE PEOPLE



PROVIDE THE BEST SCIENCE TO ANSWER SOCIETAL REQUIREMENTS

COLLABORATE ACROSS SECTORS – SHARE EXPERTISE

CONTRIBUTE TO IMPROVE SOCIAL ACCEPTABILITY



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