

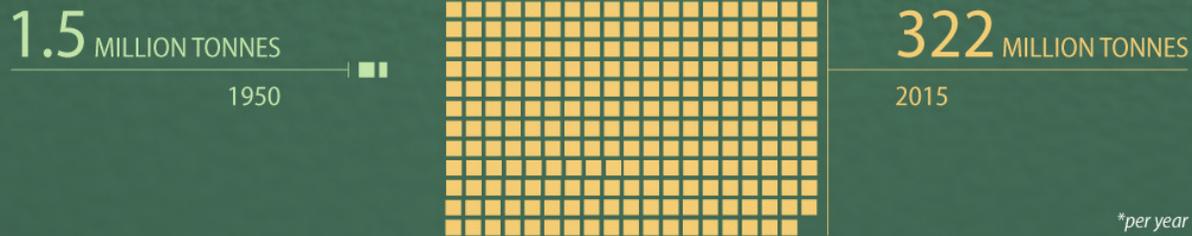
SEAWEED-BASED PACKAGING SOLUTIONS

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MAARTEN HEINS, RAMONA BOSSE, LISA KLUSMANN, FREDERIKE REIMOLD, INA
ENDERS, W. DIETMAR HOFFMANN, BELA H. BUCK**

AQUACULTURE EUROPE 2021 - MADEIRA

PLASTIC WASTE AND RECYCLING IN EUROPE

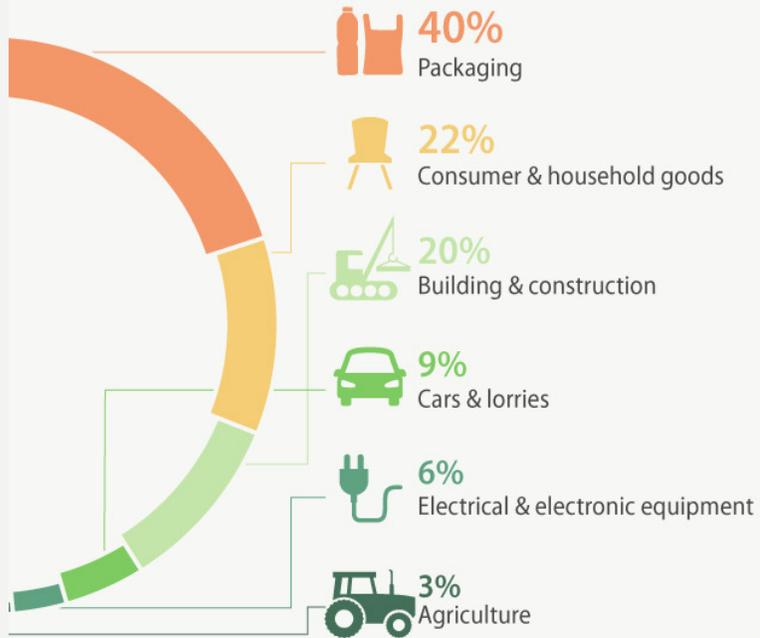
PLASTIC PRODUCTION IN THE WORLD*



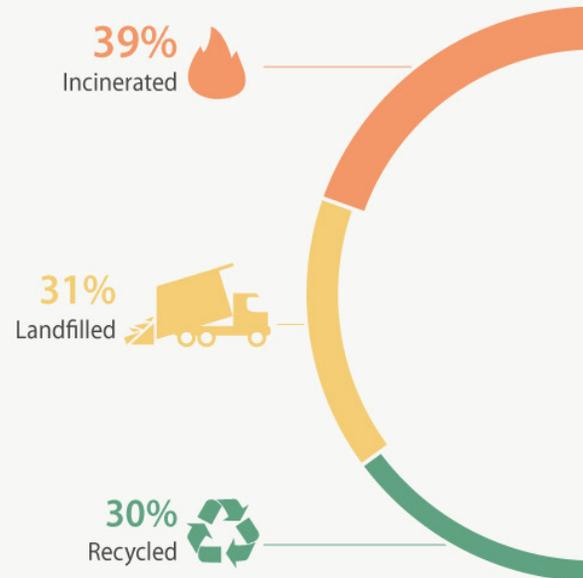
Plastic production has exploded since 1950

IN EU MEMBER STATES

PLASTIC PRODUCTION BY TYPE



PLASTIC WASTE TREATMENT

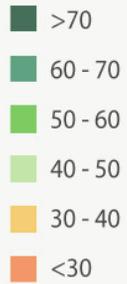


AMOUNT AND RECYCLING RATE OF PLASTIC PACKAGING WASTE (2016)*

In the EU, 40% of plastic produced is for packaging

Only 30% is recycled

Recycling rate of plastic packaging waste (%)



How is your home country doing on the recycling front?

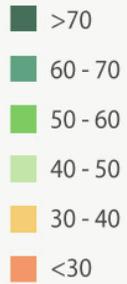
*Data from 2015

Sources: Eurostat



europarl.eu

Recycling rate of plastic packaging waste (%)



*Data from 2015

Sources: Eurostat



How is your home country doing on the recycling front?



<9%

PLASTIC POLLUTION ...WE CAN MAKE THINGS BETTER



Less than 30%
of collected plastic waste is recycled

The amount of plastic going to landfill or incineration
can be dramatically reduced


Reduce
amount of
plastic used


Reuse
when possible


Sort
properly for
recycling


Use
recycled
plastics

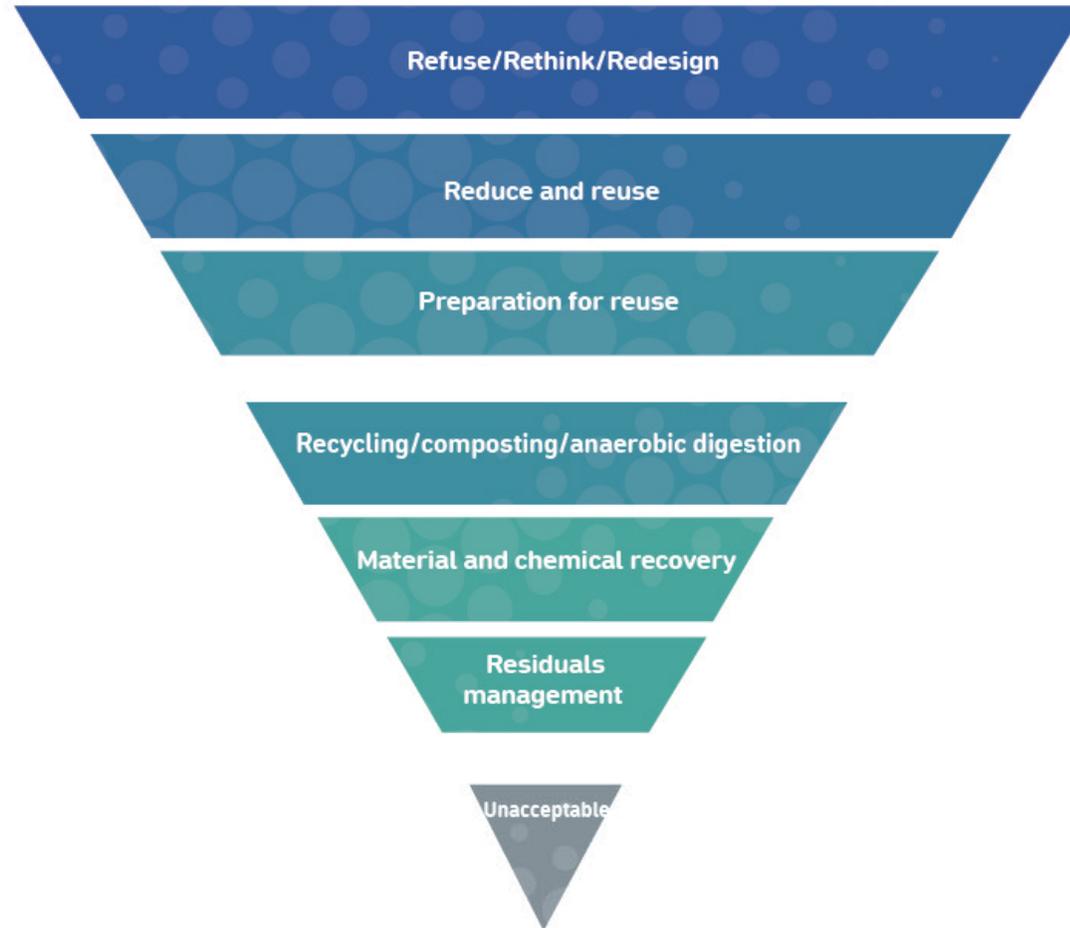
The European Commission ties all these actions together in
the Circular Economy, which covers the full life-cycle of products.



A more circular
economy is
needed -
Reduce
Reuse
Recycle

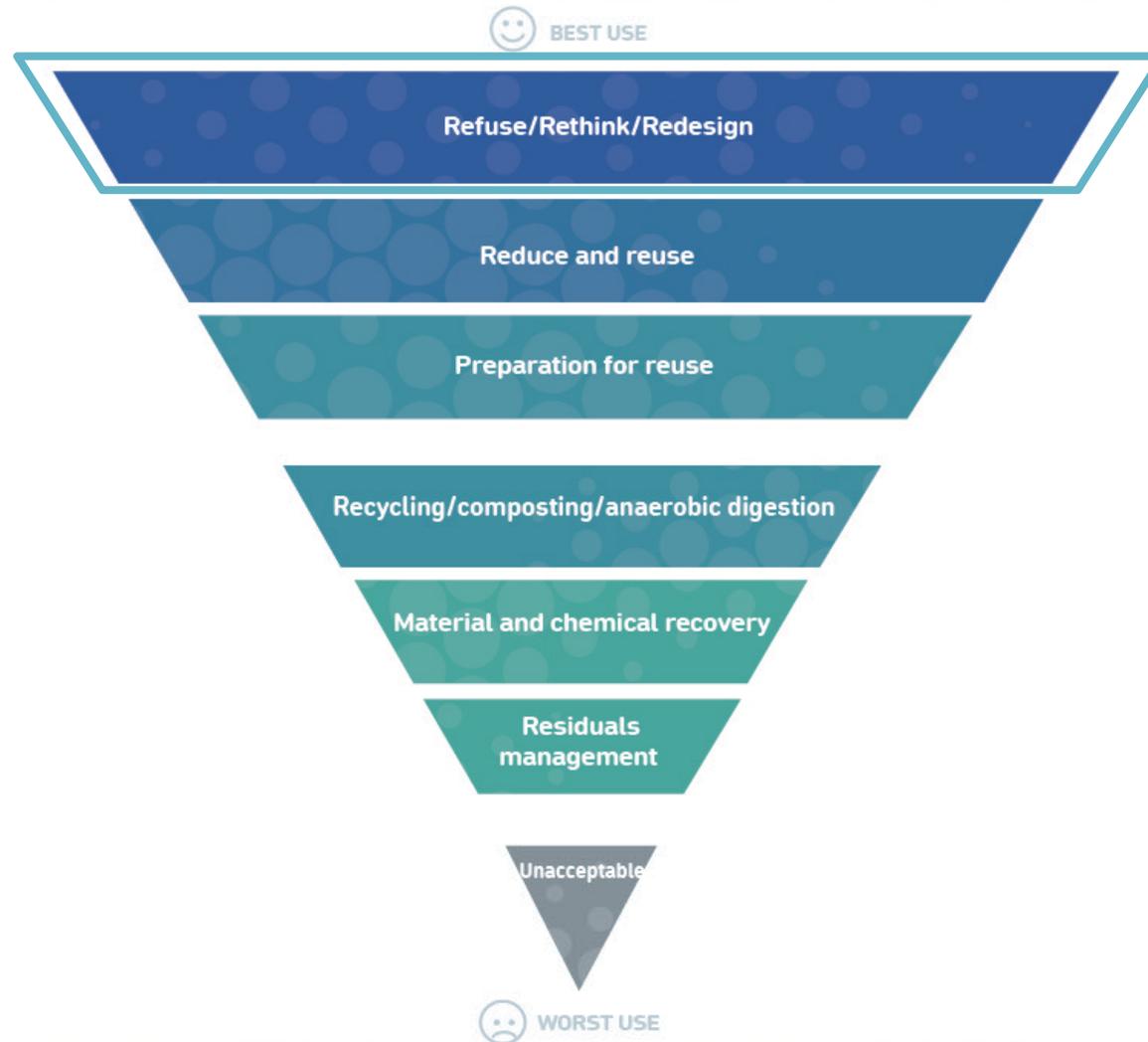
Zero Waste Hierarchy

😊 BEST USE



☹️ WORST USE

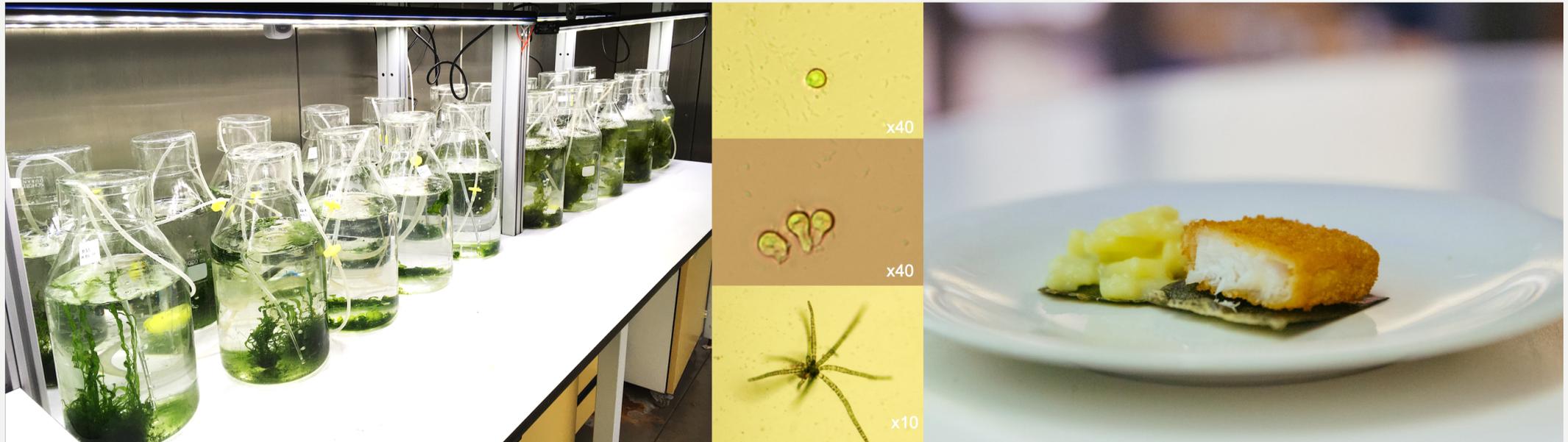
Zero Waste Hierarchy





**CAN SEAWEED
PROVIDE A
SOLUTION?**

PACKAGING SOLUTIONS FROM LAND-BASED MACROALGAE AQUACULTURE

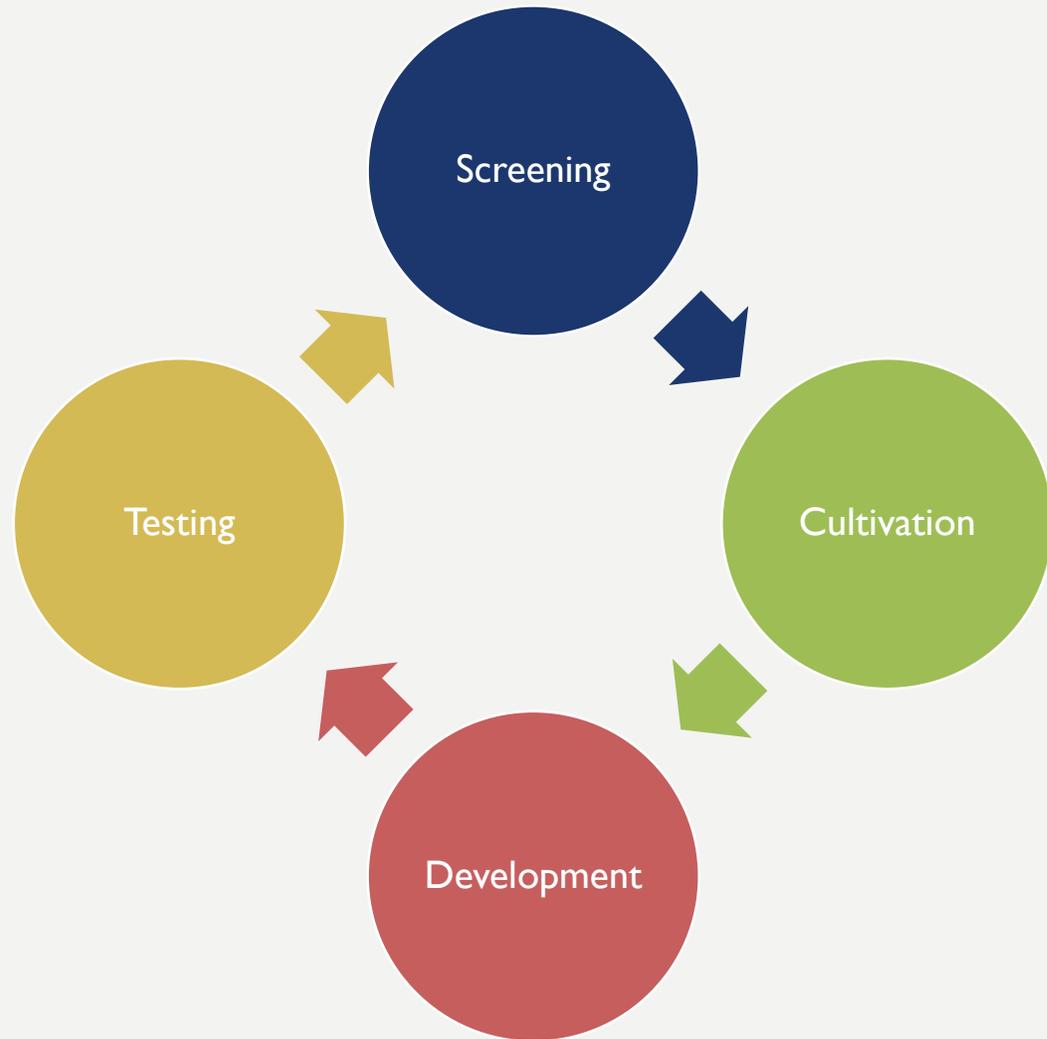


From left to right: lab-scale seaweed cultivation, algal spores developing from single cells into multicellular germlings, macroalgae-based packaging material. Foto credit: L. C. Hofmann/AWI and R. Bosse/HS Bremerhaven



MAK-PAK & MAK-PAK SCALE-UP

**SCALE-UP AND OPTIMIZE THE PRODUCTION OF
SEAWEEDS TO CREATE SUSTAINABLE, BIO-
DEGRADABLE, AND/OR EDIBLE MACROALGAE-
BASED PACKAGING MATERIAL FOR THE FAST-
FOOD INDUSTRY**



MAK-PAK

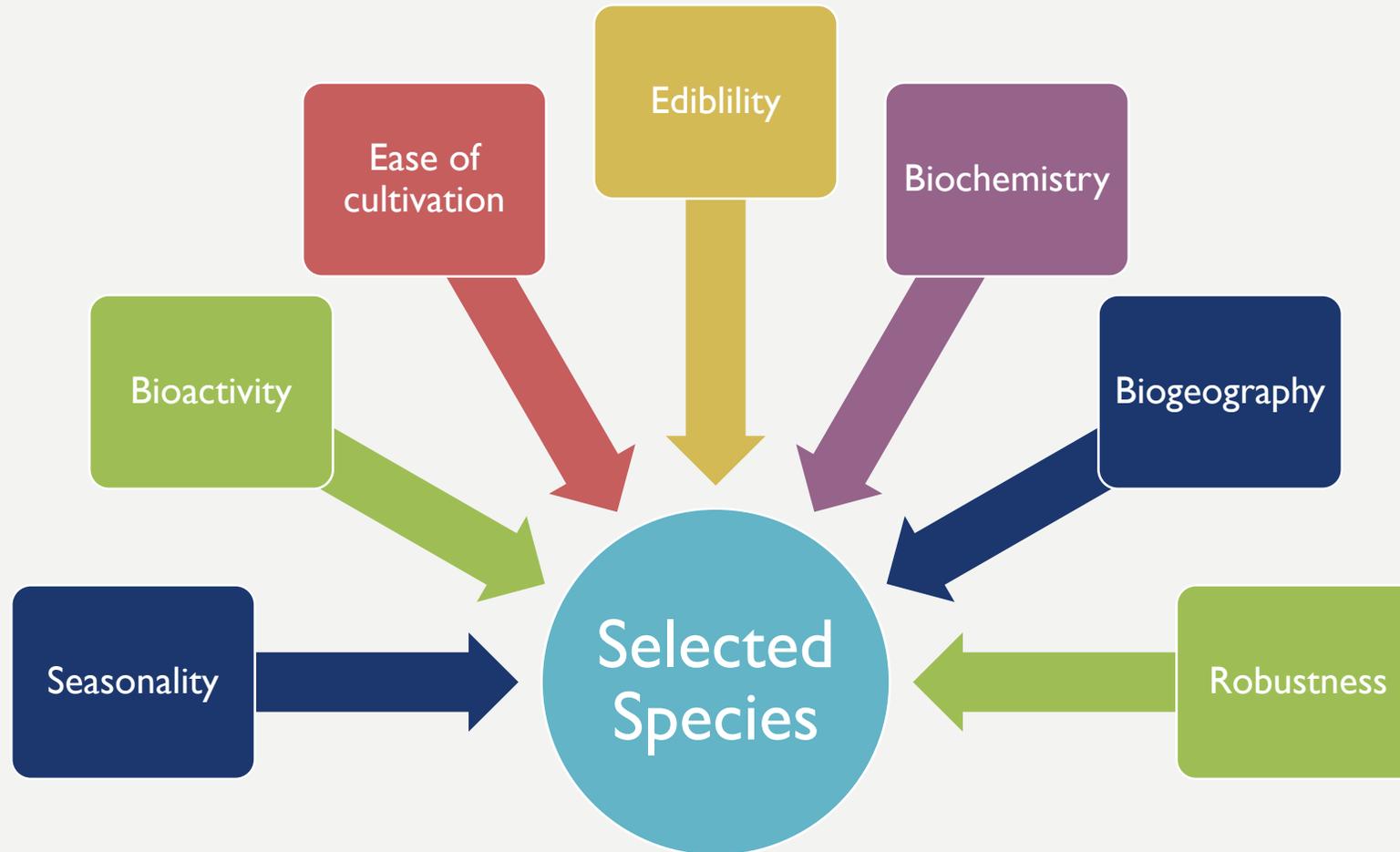
Screen local species

Produce biomass

Develop Packaging

Consumer Testing

INITIAL SCREENING PROCESS



LAND-BASED CULTIVATION



○ RAS system 1 ○○ Flow-through ○○○ RAS system 2 ○○○○ Batch Culture ○○○○ Batch Culture

PACKAGE DEVELOPMENT



○ A. Hartmann/Norderleser ○○



○○ R. Bosse/HS Bremerhaven

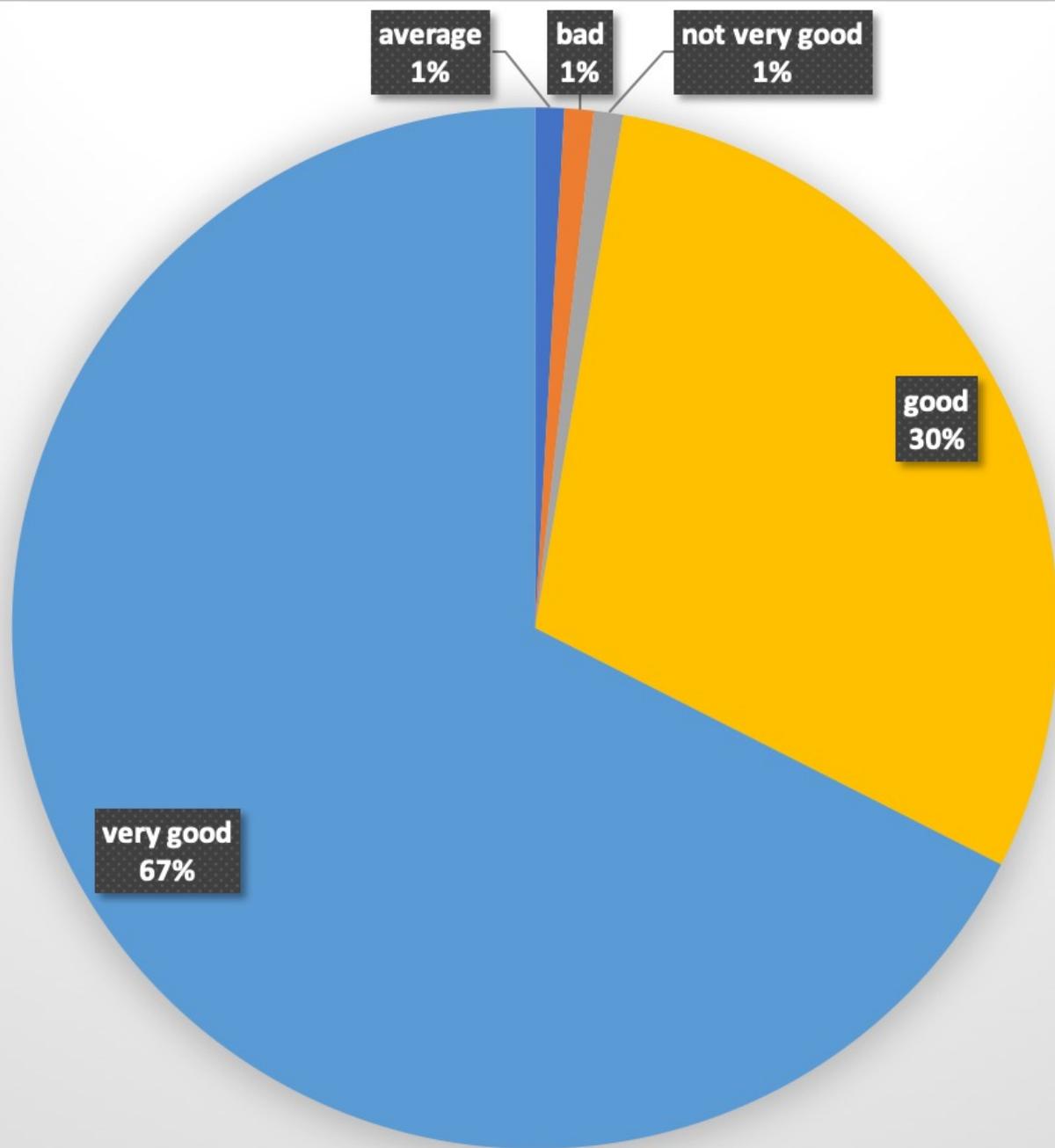
PACKAGING PROTOTYPE



○ Prototype 1

○○ Prototype 2

○○○ Credits - HS
Bremerhaven - R. Bosse



CONSUMER TESTS

97% rated the concept good to very good

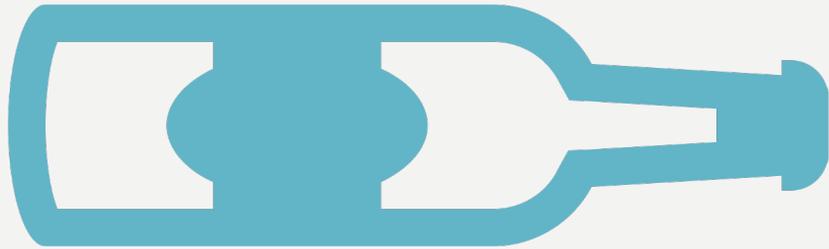
74-91% rated the combination with food good to very good (fish vs. potato salad)

89% would buy the package

Slightly salty, marine aroma

OBSTACLES & SOLUTIONS

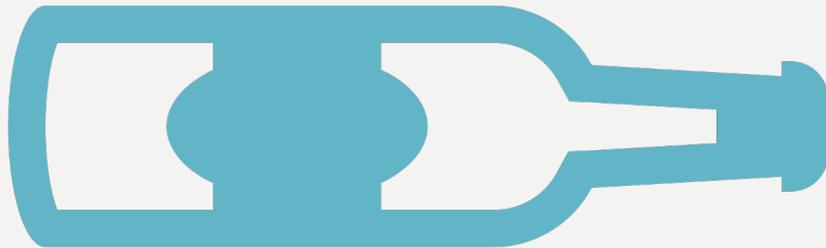
BOTTLE-NECKS



Scale of production
Cost of production

OBSTACLES & SOLUTIONS

BOTTLE-NECKS



Scale of production
Cost of production

SOLUTIONS

Scale-up

- New partners

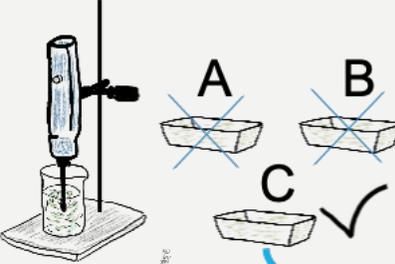
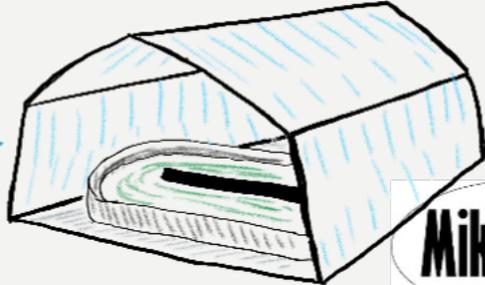
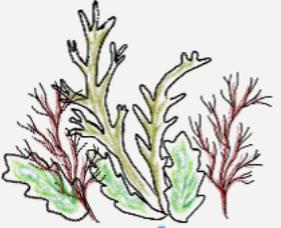
Cost

- Additional plant biomass

WORK-FLOW



+



Hochschule Bremerhaven



With support from

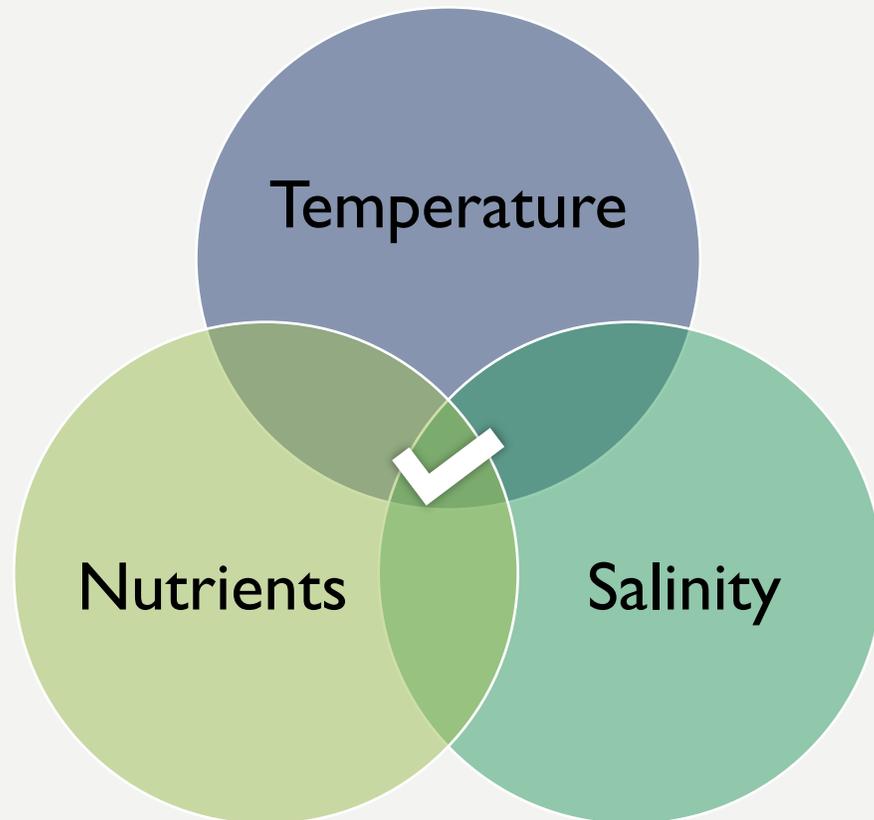


Project manager



by decision of the German Bundestag

OPTIMIZATION OF LAND-BASED RAS SYSTEMS



STRAIN SELECTION & BREEDING

Heterosis results
when a hybrid is
produced with
traits superior to
both parents



Generation 1

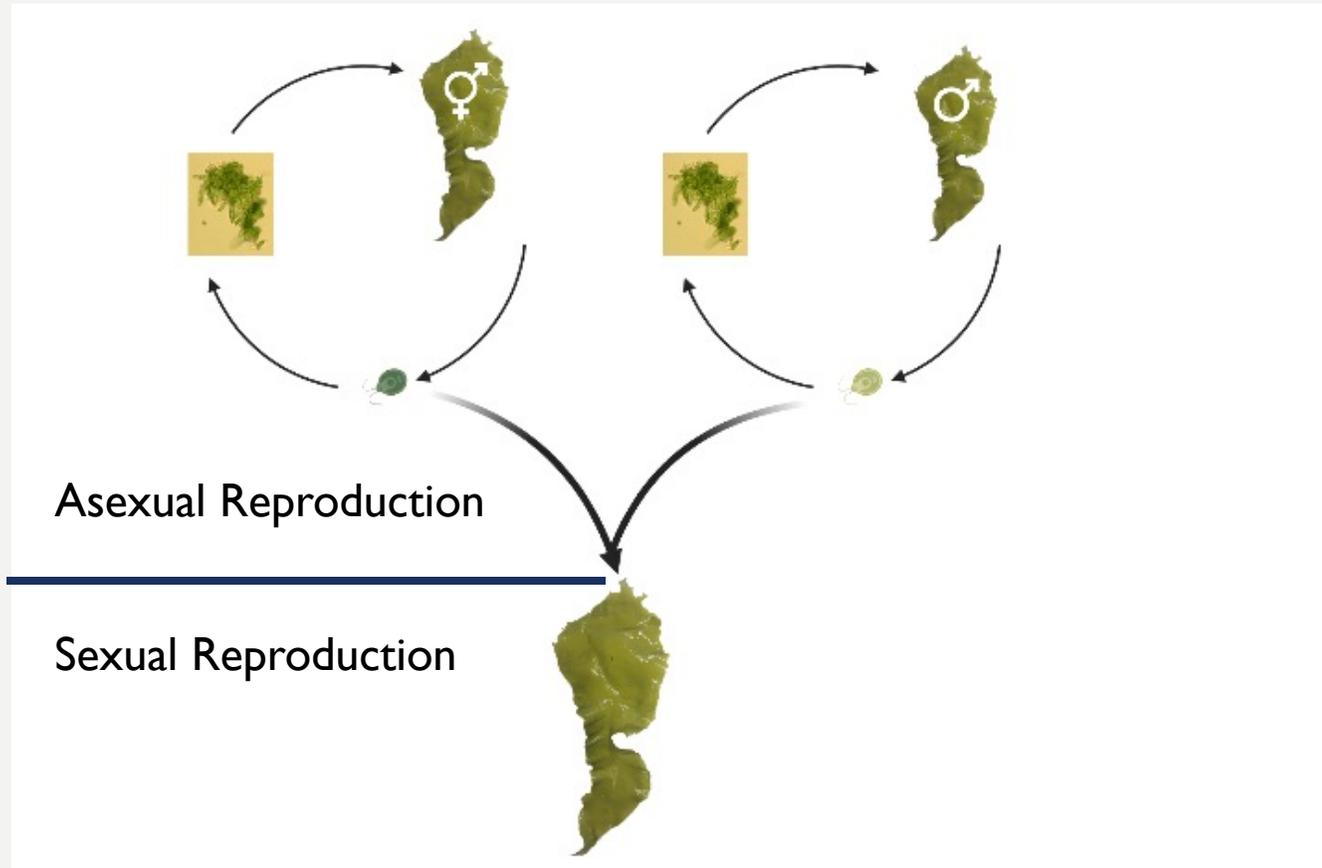
Generation 2

STRAIN SELECTION & BREEDING

Maintain male and female cultures of isolated strains

Induce reproduction when needed

Supply hybrid with advanced traits



BROADER IMPACT



Part of the EU Green Deal



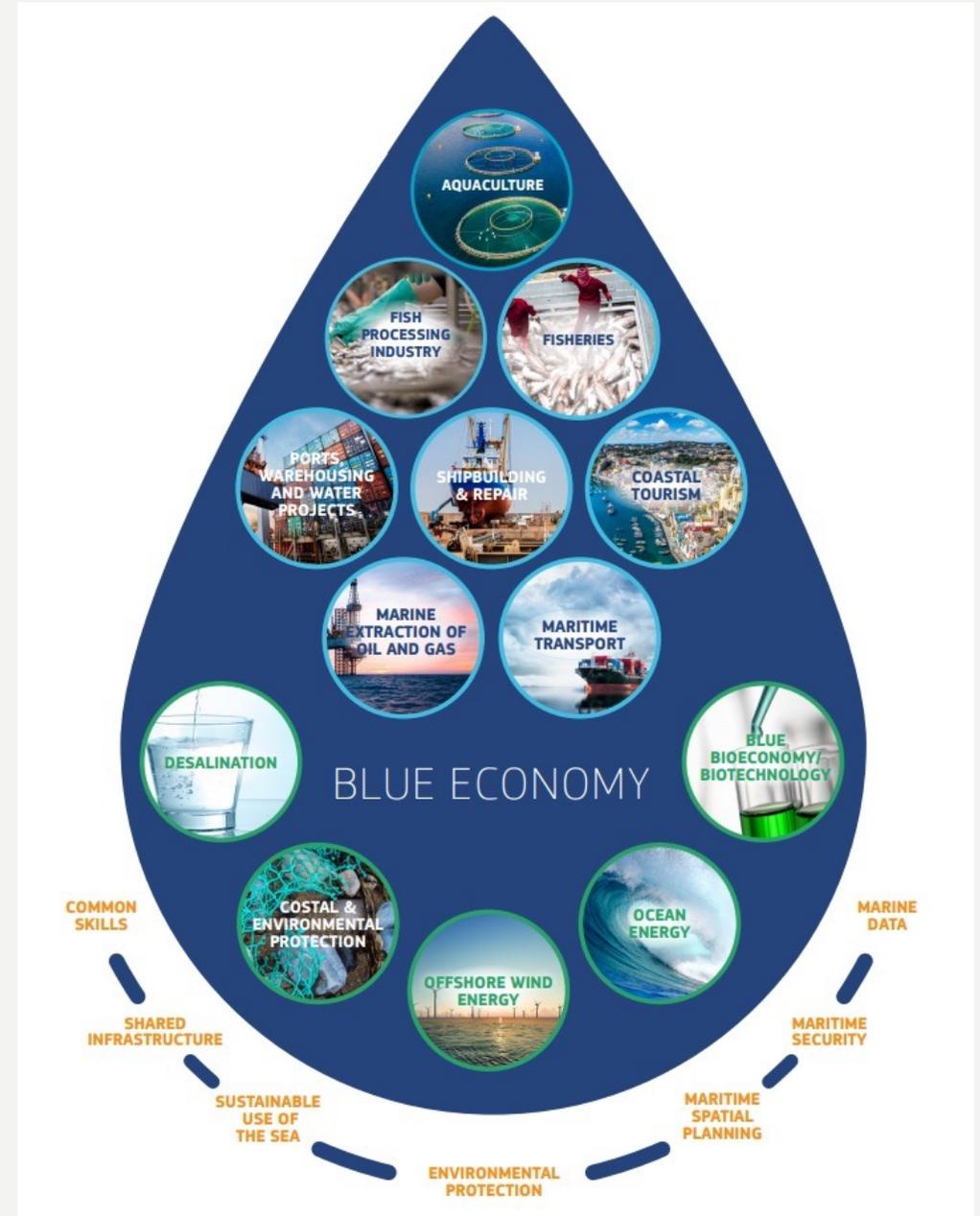
- Reduce pollution
- Increase sustainability

BROADER IMPACT

Contributes to Blue Economy



- Sustainable Aquaculture
- Biotech
- Carbon neutral





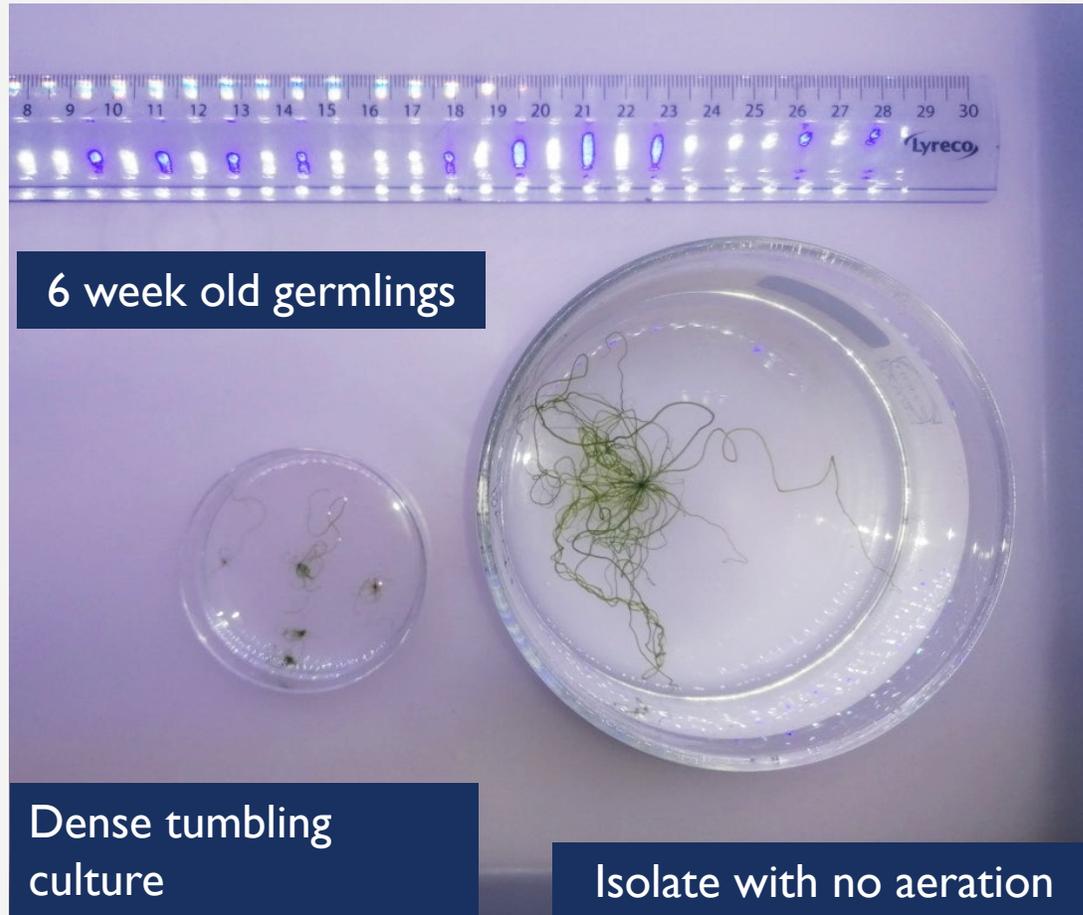
**THIS IS A SUCCESS STORY FOR
SUSTAINABLE AQUACULTURE AND
MACROALGAE CULTIVATION IN
GENERAL.**



**WE ARE INCREASING PUBLIC
AWARENESS OF MACROALGAE AND
CONTRIBUTING TO A DIALOGUE
ABOUT THE DIVERSITY OF
PRODUCTS AND SERVICES THAT
THEY PROVIDE AS WE STRIVE
TOWARDS A SUSTAINABLE,
CIRCULAR ECONOMY**

THANK YOU

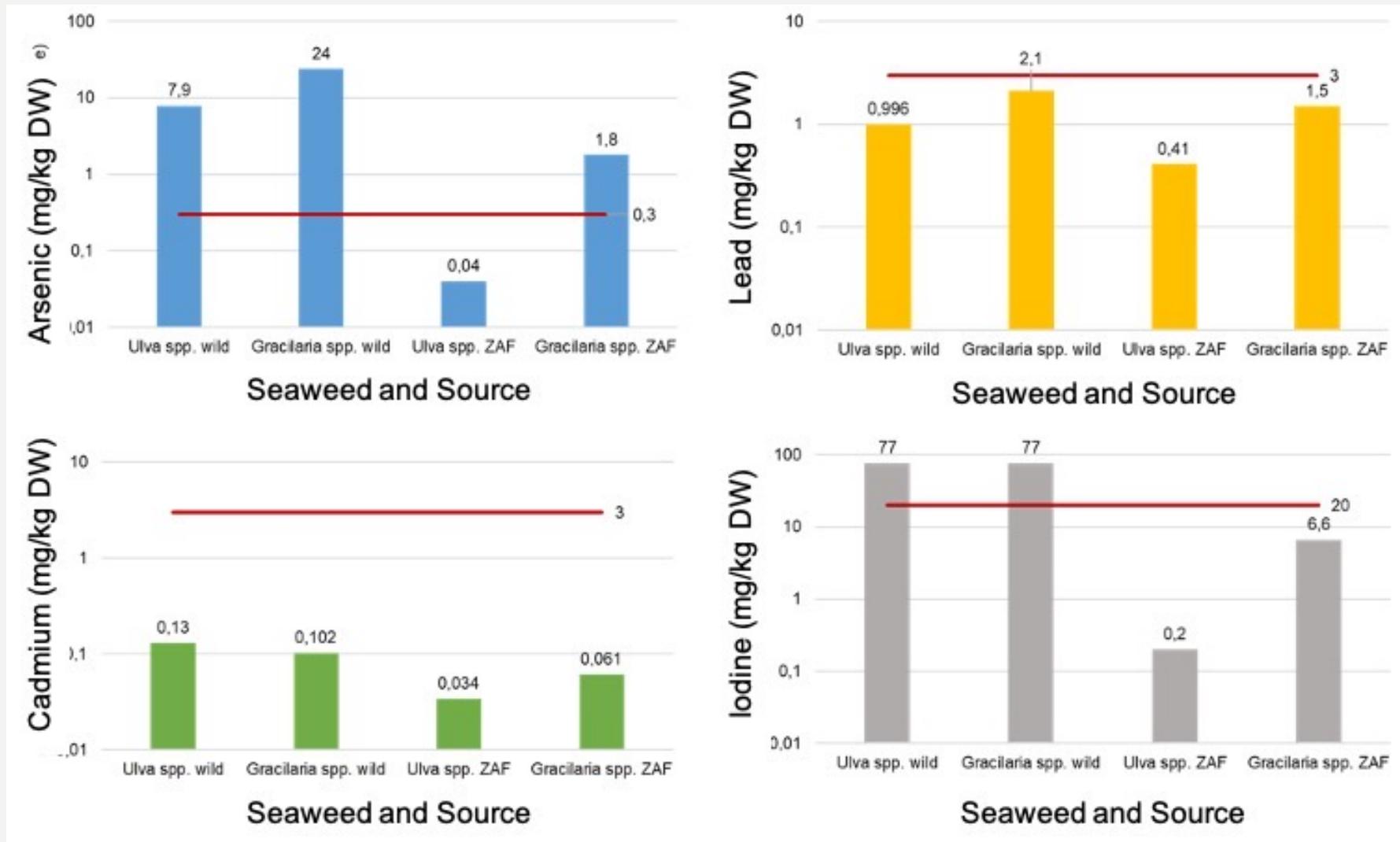
DIFFERENT CONDITIONS = DIFFERENT GROWTH RATES



The complete life cycle of *U. compressa* from single cells to mature gametophytes can be achieved within **6 weeks**

With continuous induction of reproduction, we can provide material for transplantation to large-scale systems on a regular basis

BENEFITS OF ARTIFICIAL SEAWATER



BENEFITS OF ARTIFICIAL SEAWATER

	Ulva sp. wild	Agarophyton sp. wild	Ulva sp. ZAF	Agarophyton sp. ZAF	PackagingPrototype
Total Micro.	$1,1 \times 10^4$	$1,1 \times 10^6$	$7,0 \times 10^2$	$2,5 \times 10^5$	$5,5 \times 10^5$
Yeast	< 100	<100	<100	<100	<1000
Mold	< 100	< 100	500	100	< 1000
Enteros	< 100	100	< 100	100	$3,7 \times 10^4$
E. coli	< 10	20	< 10	< 10	< 100
Salmonellen	neg.	neg.	neg.	neg.	-
Listerien	neg.	neg.	neg.	neg.	neg.
B. cereus	< 10	< 10	20	30	-
Vibrio	neg.	neg.	neg.	neg.	-