Surplus Energy and Food Production.

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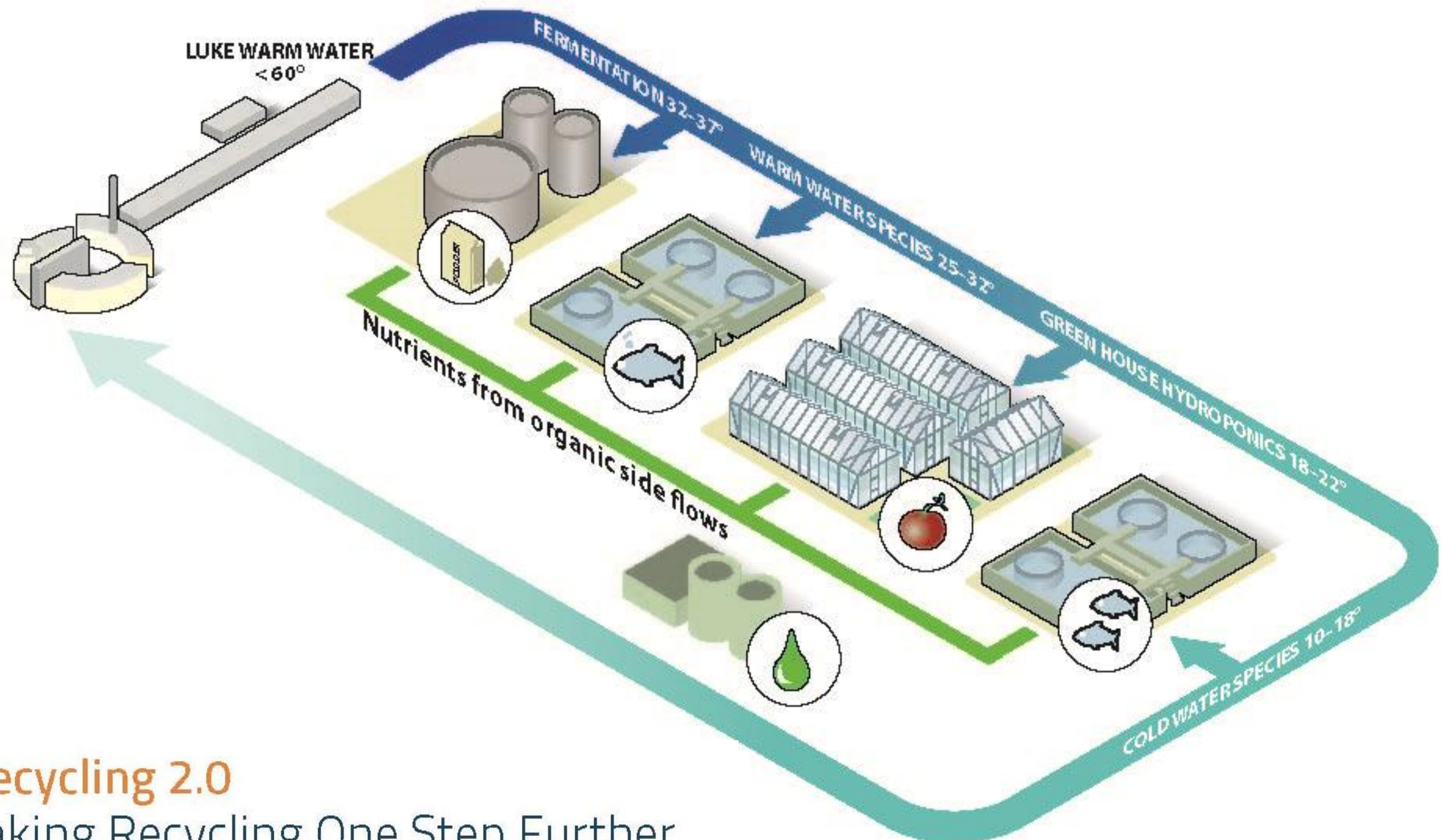


Recycling 2.0
Taking Recycling One Step Further

Illustration Peter Lönnegård & FredrikIndebetou

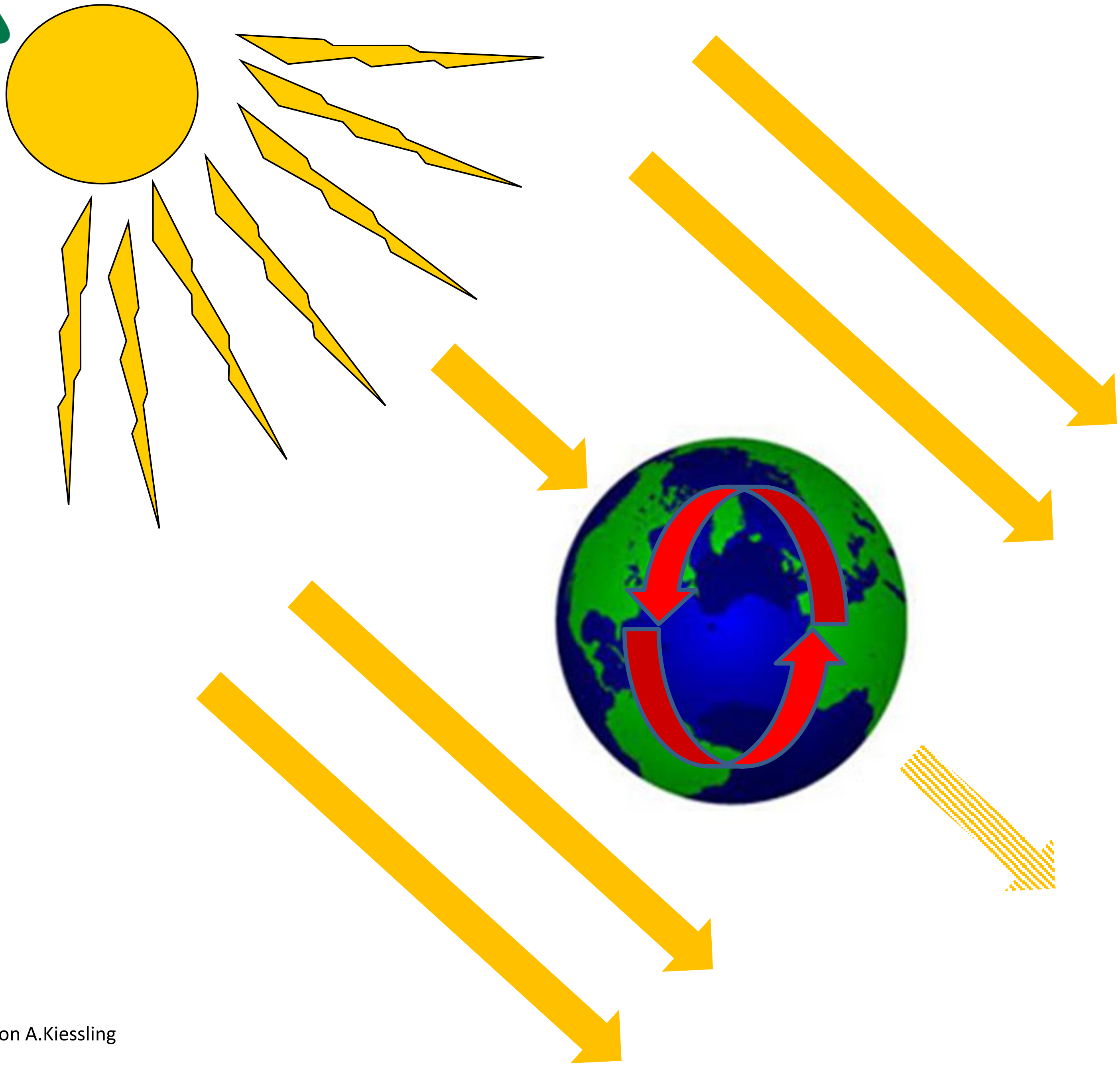
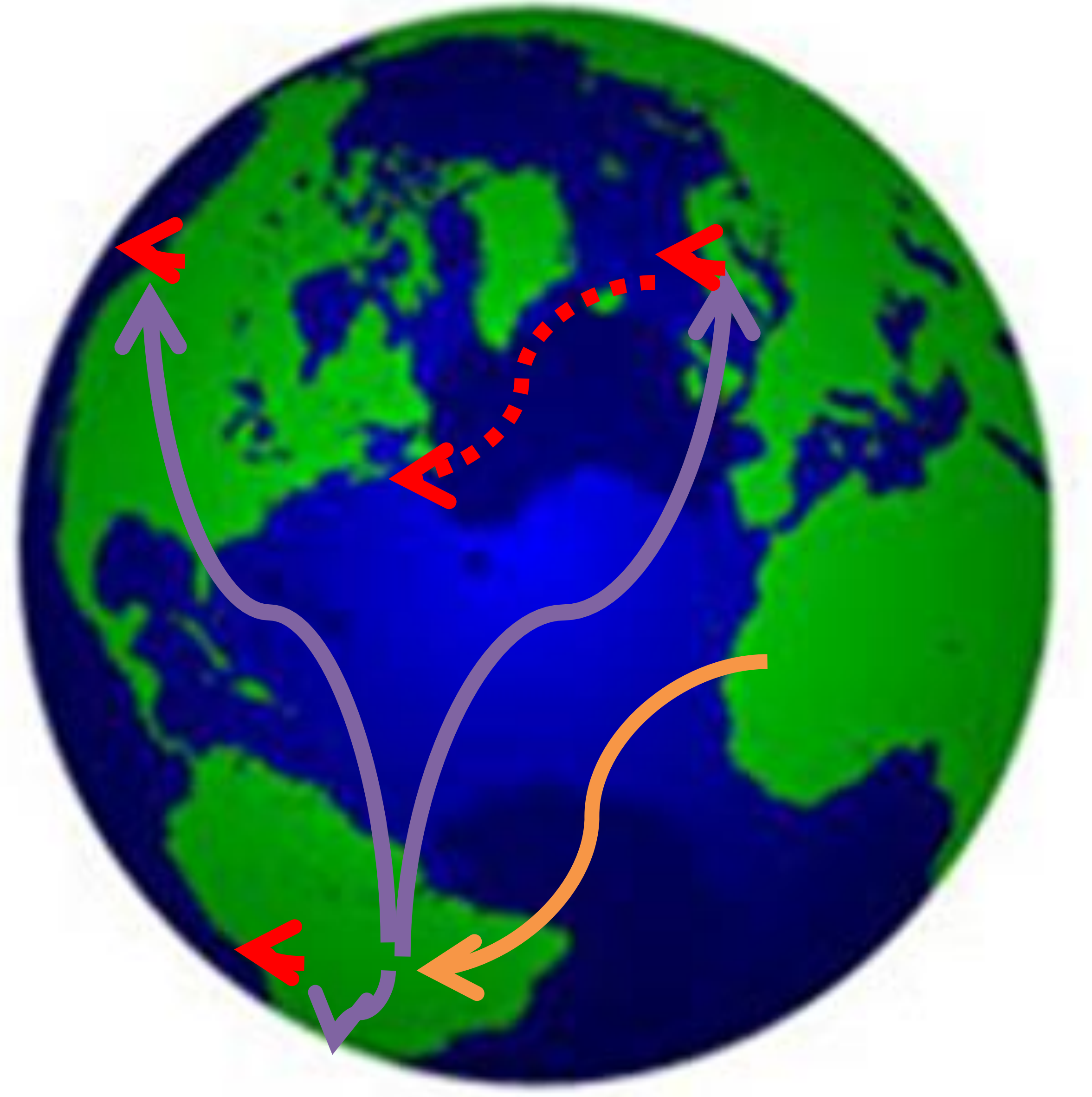


Illustration A.Kiessling

The linear flow of nutrients,



which by default will lead to deprivation at one point and accumulation at another

Illustration A.Kiessling

Food productivity, on the other hand,
Is a direct function of this energy influx in combination with access to fresh water.

An increase in temperature from 8.6 to 13.7 ^{o}C doubled the growth rate in salmon smolt.

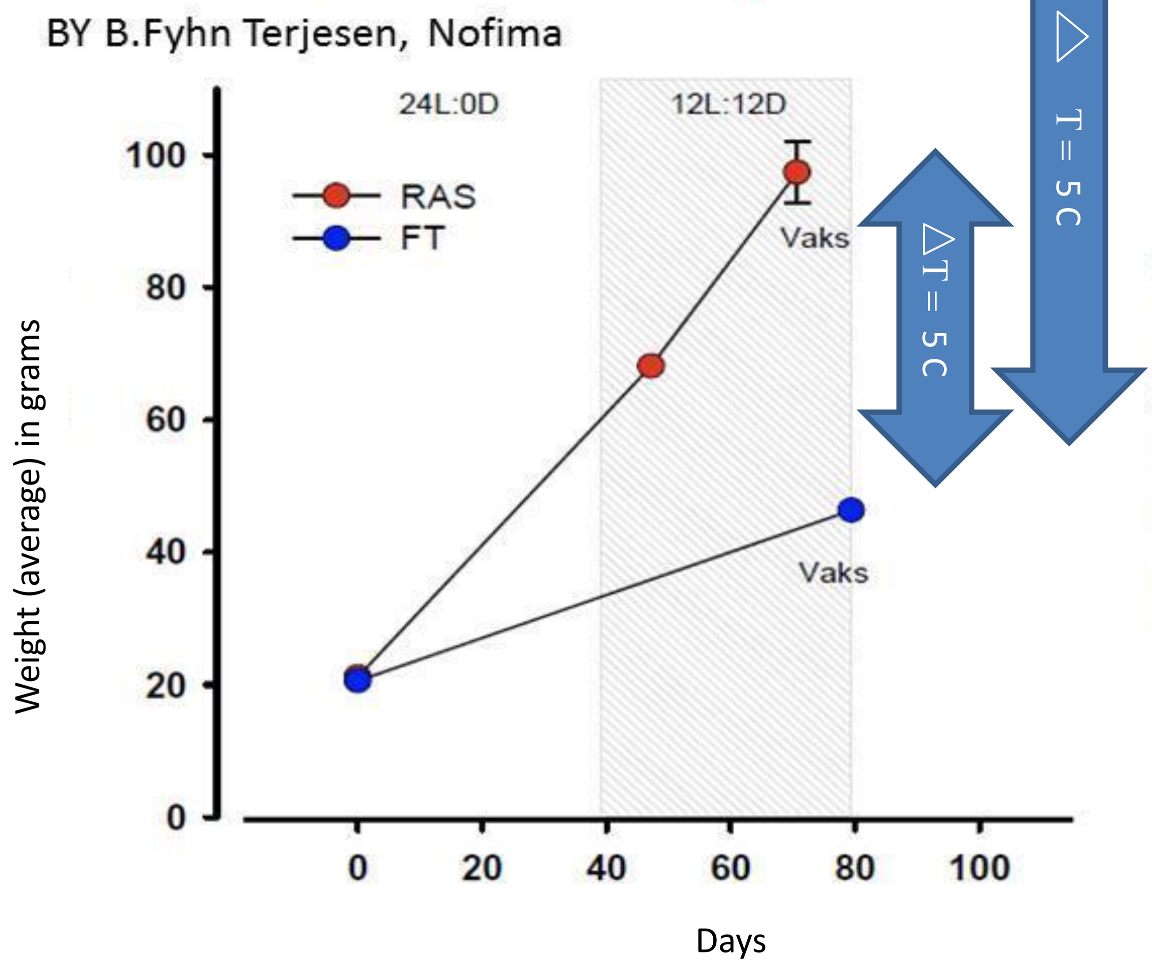


Photo A.Kiessling

Surplus Heat

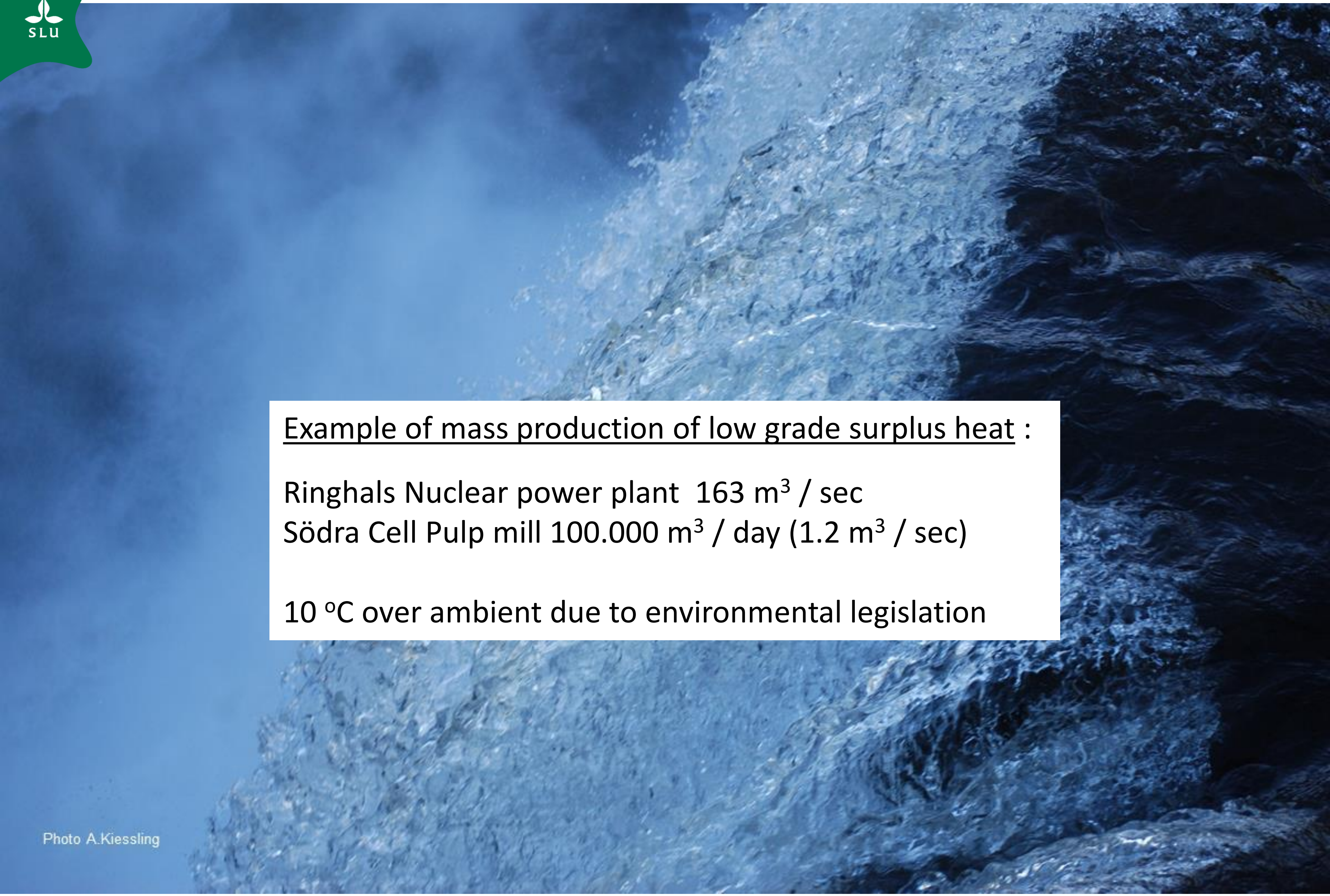
1. Enormous amounts of heat < 60 ^{o}C is lost as cooling, ventilation or insufficient insulation.

2. In Sweden it is estimated to 150 TWh => ¼ of Swedish energy use.

3. In EU it is estimated to 500 billions Euro in petrol equivalents.

4. **Growth of fish, plants, algae are all stimulated by a moderate increase in temperature.**

Photo A.Kiessling



Example of mass production of low grade surplus heat :

Ringhals Nuclear power plant 163 m^3 / sec
Södra Cell Pulp mill 100.000 m^3 / day (1.2 m^3 / sec)

10 ^oC over ambient due to environmental legislation

Is there an advantage to produce in water when utilising low grade surplus heat ?

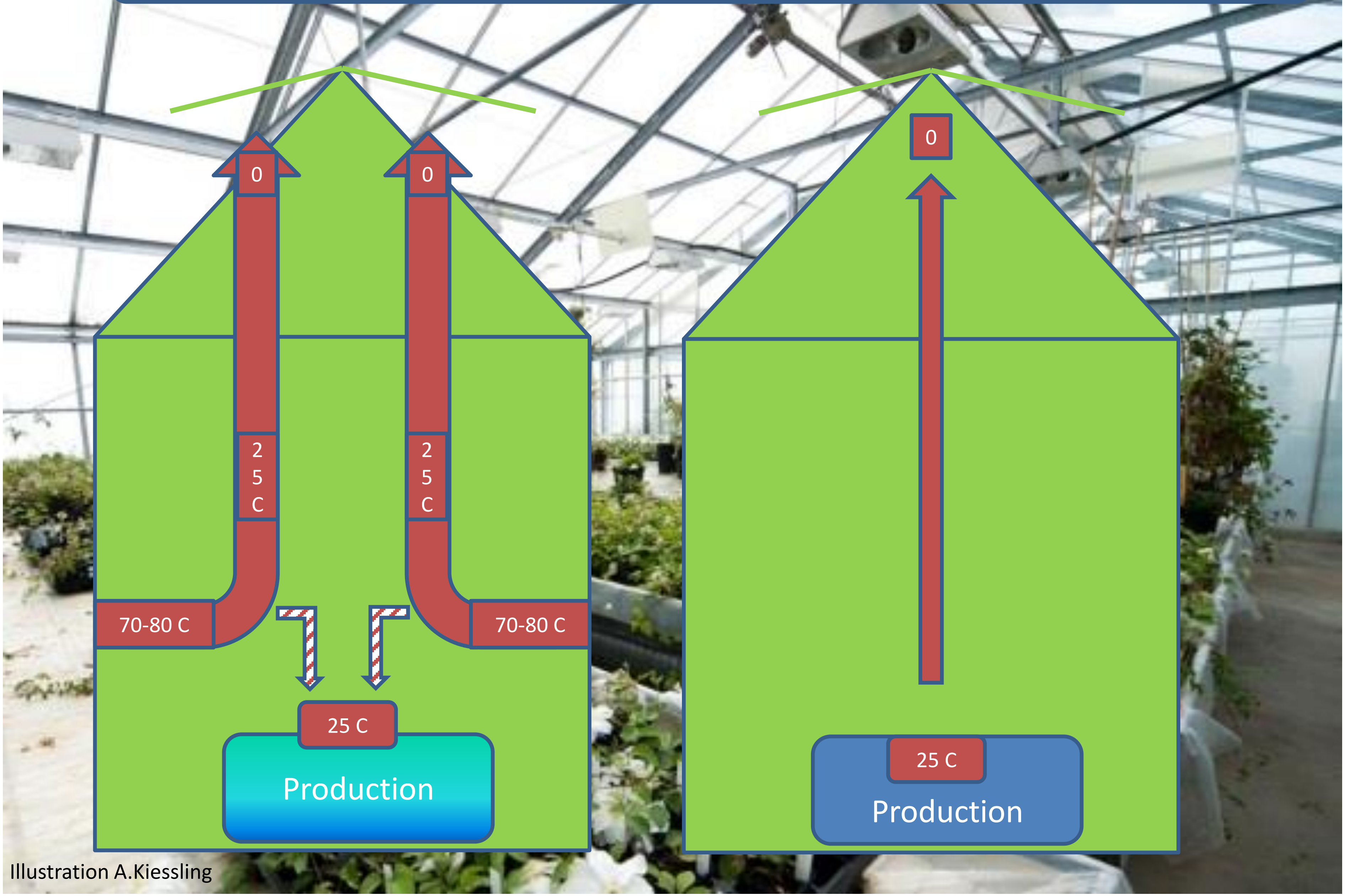


Illustration A.Kiessling

Cooling chain: From heat to food

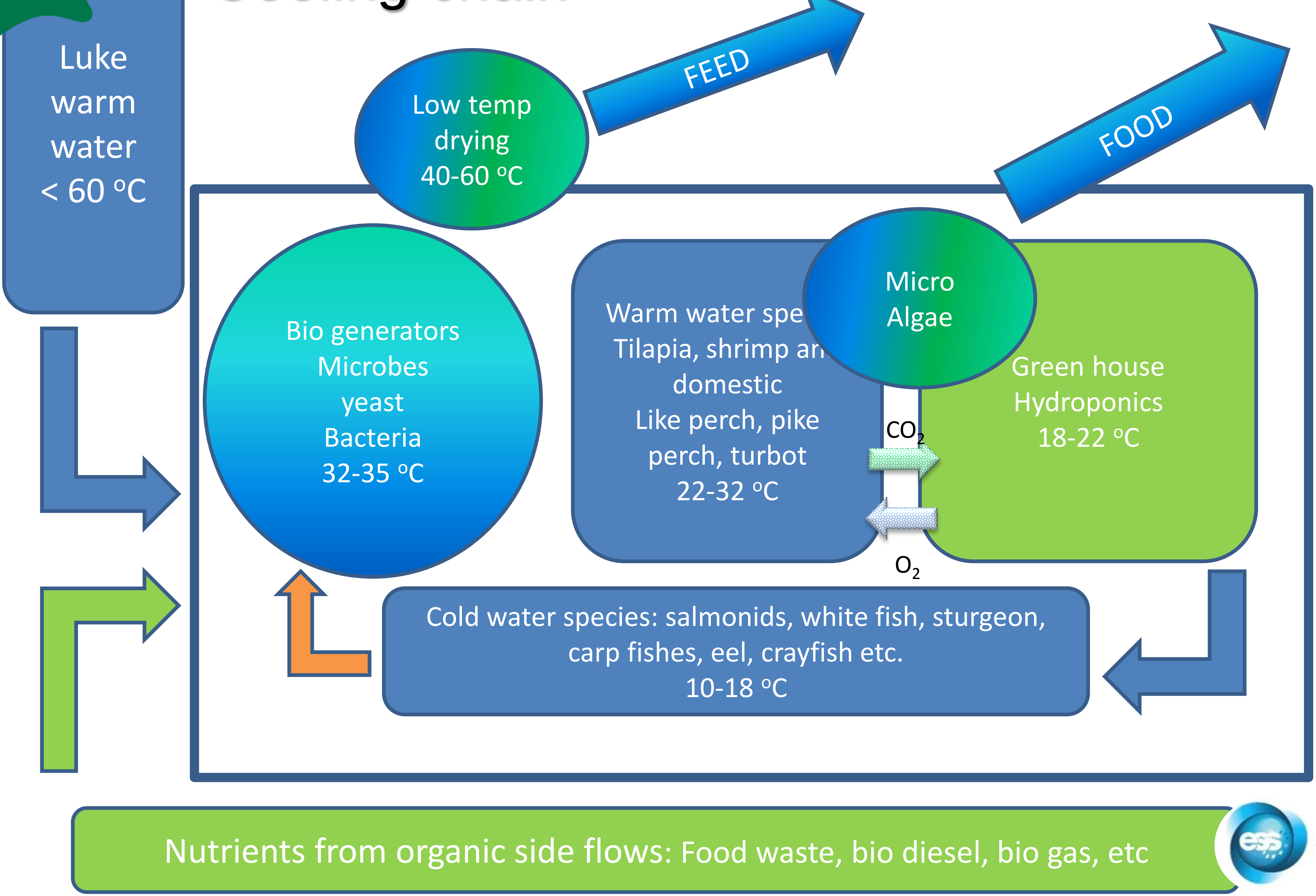
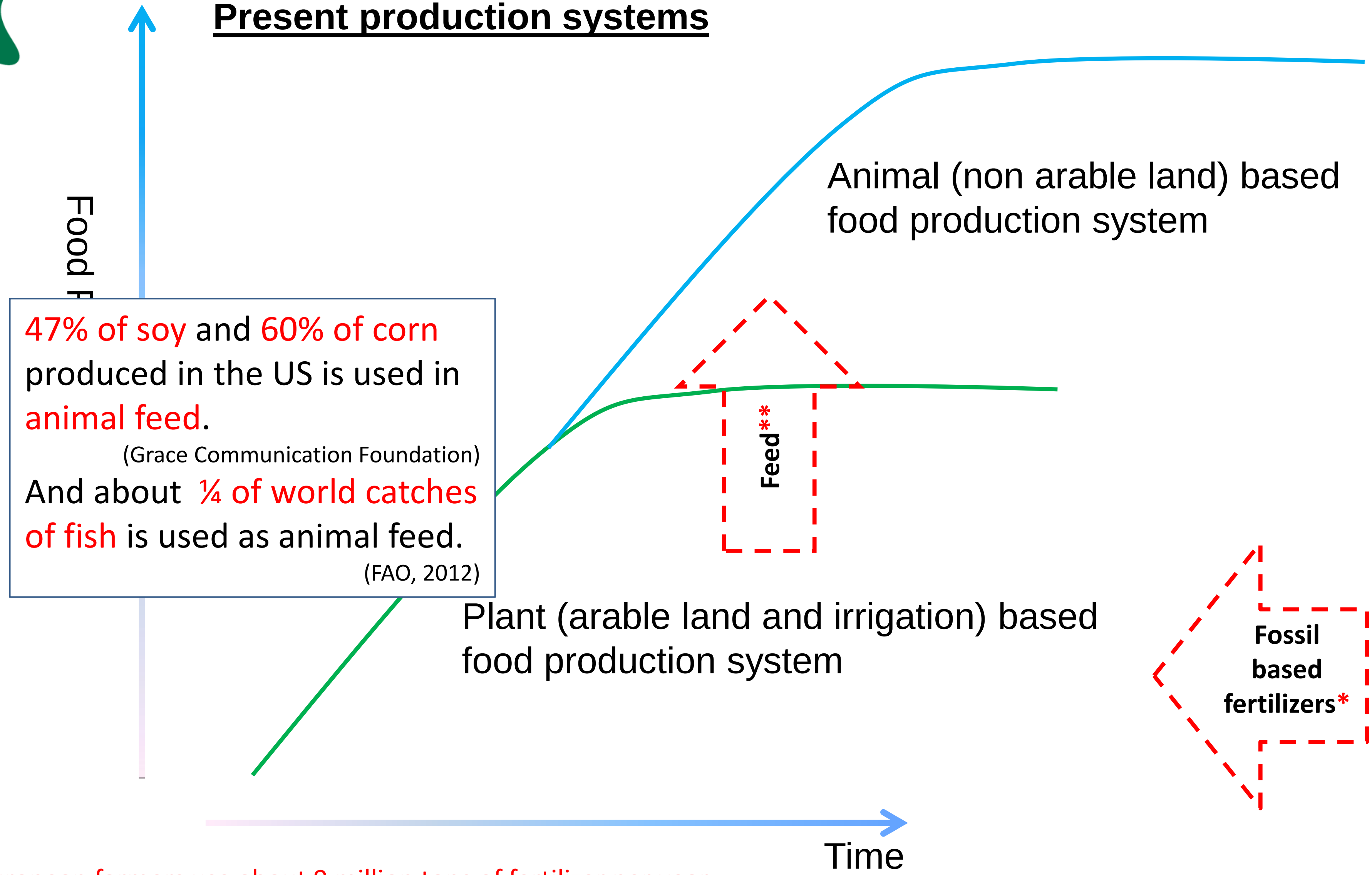


Illustration A.Kiessling

Present production systems



*European farmers use about 9 million tons of fertilizer per year

**European farmers import the equivalent of 50 million tones of soybean per year.

Illustration A.Kiessling

Food Production

The Problem !! We end up with less food

$\Rightarrow$Fluctuating and increasing prices

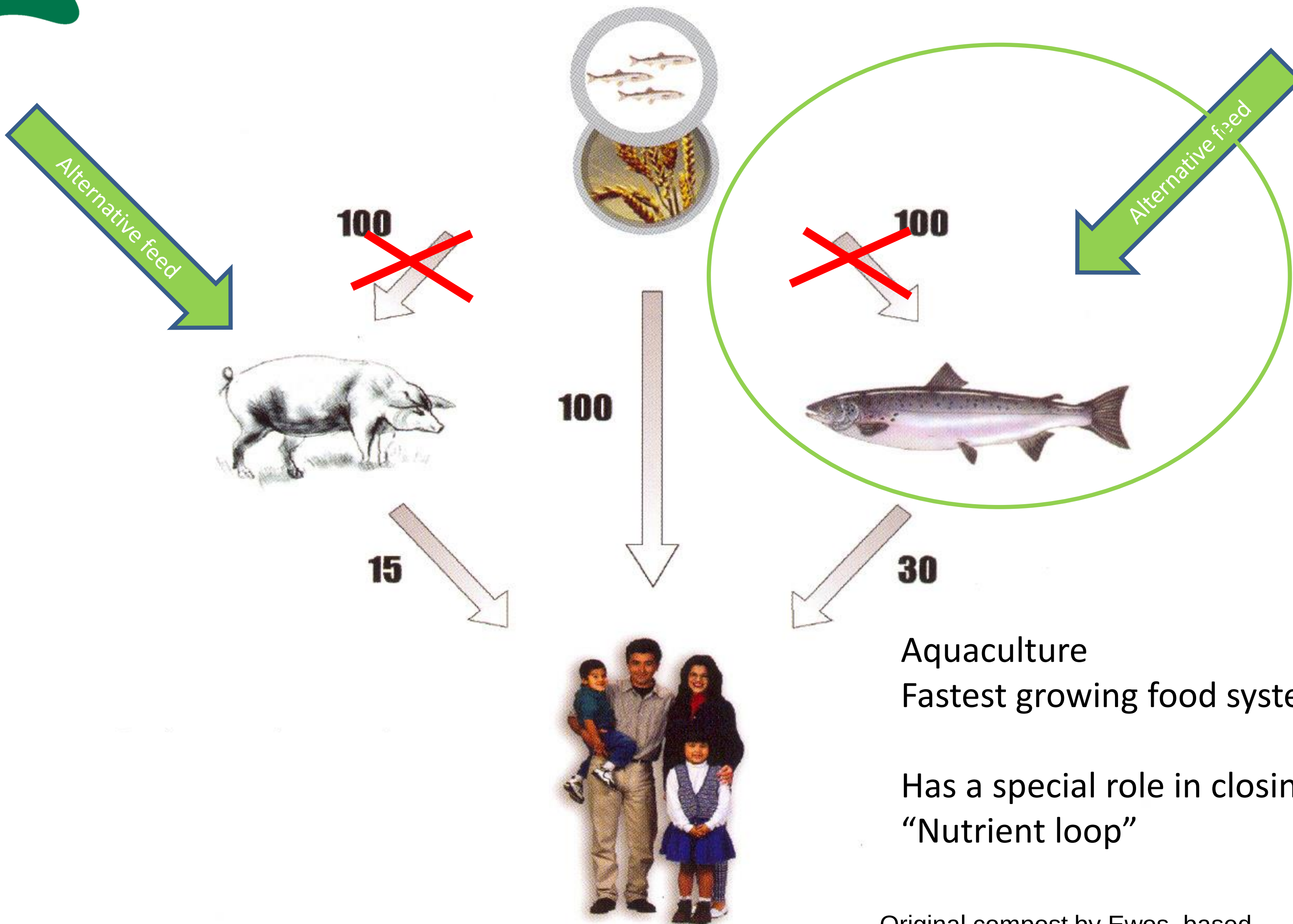
And if combined with local weather effects =>

The OECD/FAO Outlook warns: A wide-spread drought such as the one experienced in 2012, on top of low food stocks, could raise world prices by 15-40 percent."

Time

Illustration A.Kiessling

Animal or Man ?

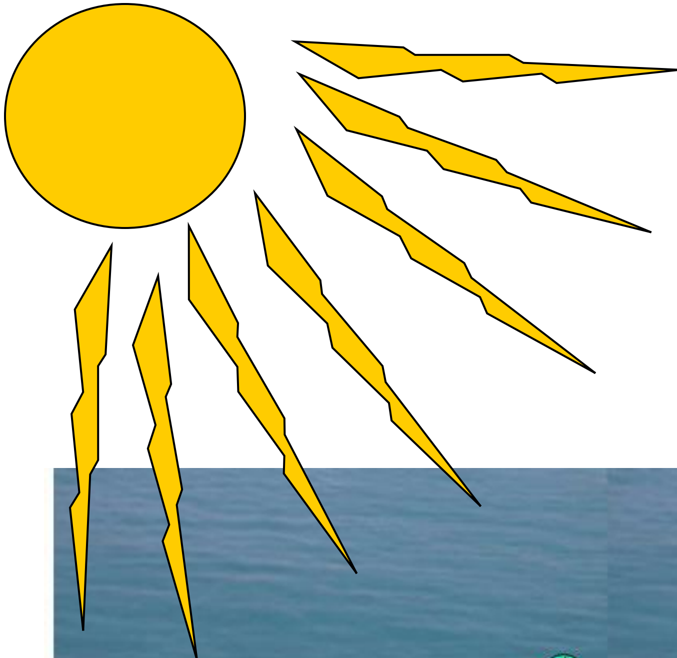


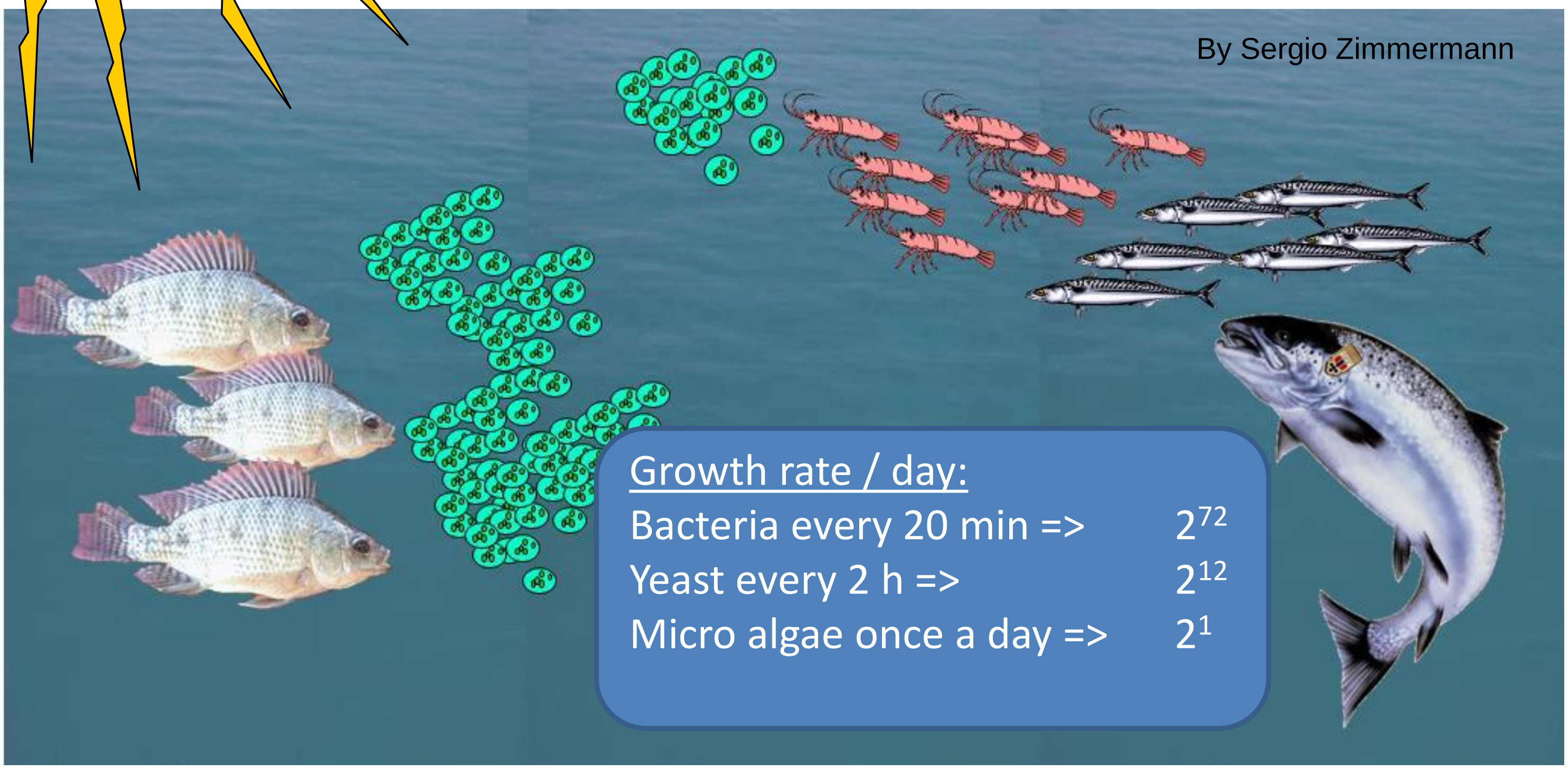
Aquaculture
Fastest growing food system

Has a special role in closing the :
“Nutrient loop”

Original compost by Ewos, based
on Åsgård et al. 1999

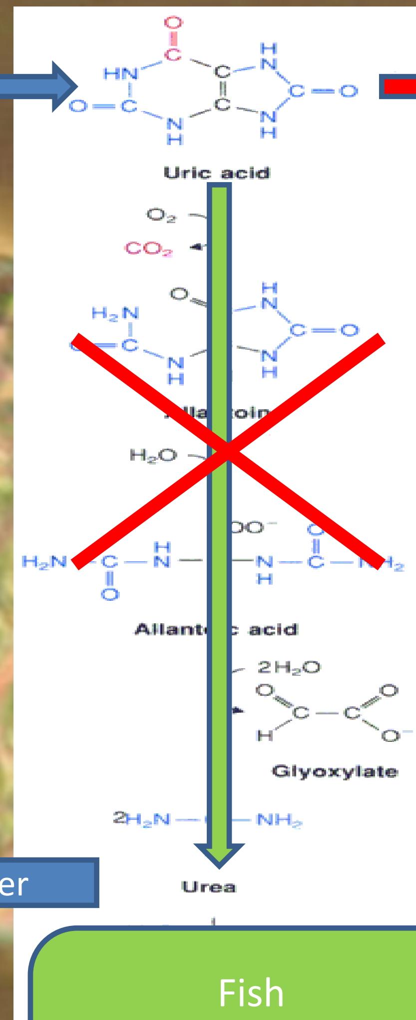
Microbes are the base of the food web evolution of all higher animals including ruminants.





Microbes have high levels of RNA (10-15%) due to high protein synthesis.

Living cells metabolizing the N in RNA to:



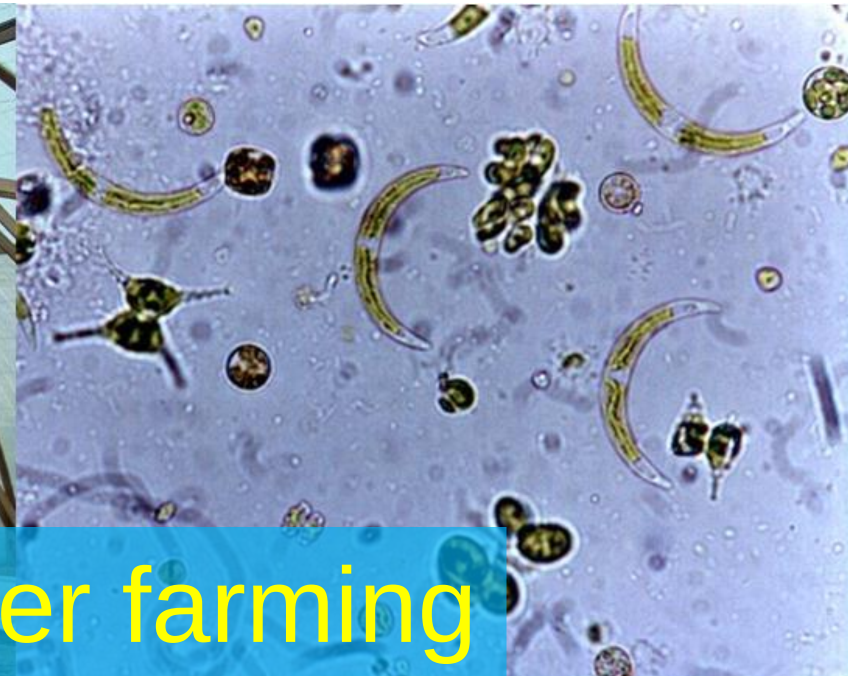
In mammals uric acid => kidney stones and gout

RNA relay the information of DNA to the protein synthesis

To water

Fish
=> Has all enzymes to eat large amounts of microbes

Picture courtesy of Matilda Olstorpe

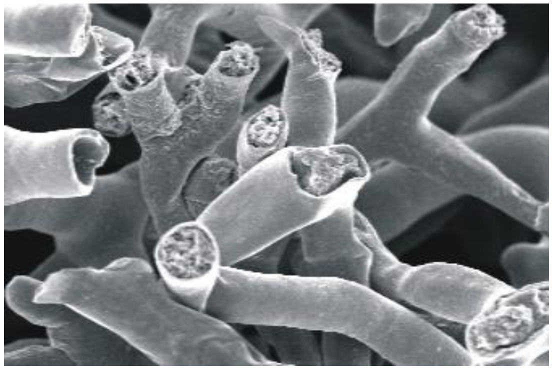



25-30 °C

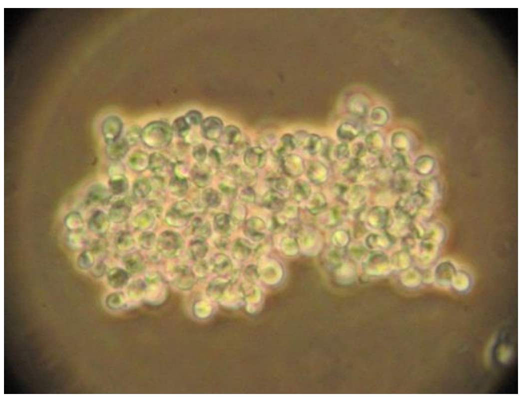
Green water farming

By Sergio Zimmermann

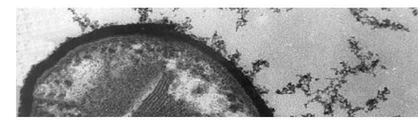

Microbial protein / Bio-protein meal



Micro fungi



Yeast



Need low temp drying (otherwise reduced quality)

10% DM in bio-generator

90% DM in protein meal

Need 30 mil. ton protein to aquaculture alone 2030

=> Dry 48 mil. ton water

'a

Swedish Yeast company. Produce 20.000 ton yeast/year

1. 10 mg of yeast => 150 ton, in a week.

2. Global protein production by wheat: 1.74×10^3 ton protein => **9.7×10^6** ton protein
   (low in lysine, arginine and methionine).

3. If use same amount of yeast protein using: $(1.74 \times 10^3) / 10^{-5}) \times 150 \times 52$ = **1.4×10^{12} ton protein**
   (amino acid composition as fish meat)

4. If makes salmon feed of 40% protein (90% DM), with a FC of 1 and a slaughter yield of 60% =>
   3.3×10^{12} ton of salmon

5. Present production and harvest of fish, given as fillet, is roughly 1.2×10^8 ton of fish

6. To dry that amount of yeast (48% protein content) one needs $4.2 \times$ **10^{15}** kwh (1.5 kwh/kg yeast)

7. Present global soy meal production is roughly 113 million ton
   1.3 **x 10^8 ton soy meal (48% protein)** => 3.6 **x 10^{11} kwh (mainly fossil)**
   1.3 **x 10^8 ton fish meal (72% protein)** => 5.8 **x 10^{11} kwh (mainly diesel)**
   1.3 **x 10^8 ton yeast (48 % protein)** => 1.9 **x 10^{11} kwh (low temp (surplus) energy)**

Picture courtesy of Matilda Olstorpe

Do we need to care ?

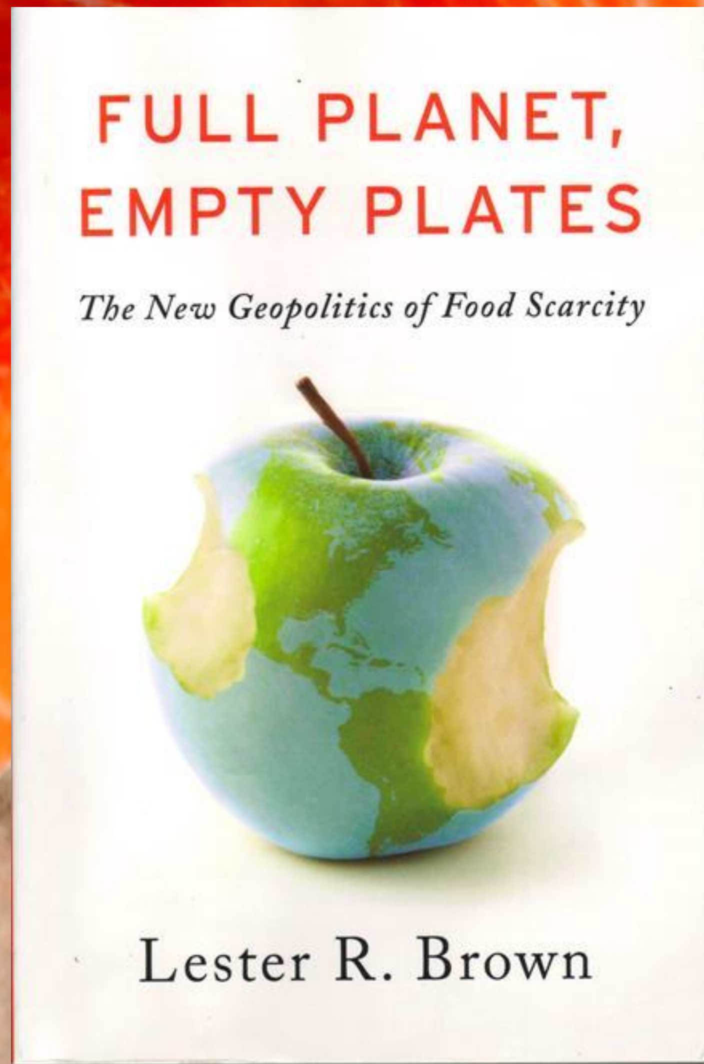


Photo courtesy of Aquabest

Food is second to drinking water the most central priority to man

1. Global food security is based on wheat, soy, corn, rice.

2. We loose arable land due to present farming practices and human activities.

3. We treat our fresh water as waste baskets and in the same time is many rivers dry even before reaching the sea due to irrigation.

4. We postulate: As we must turn to more sustainable farming techniques and a more sensible use of artificial fertilizers, **plant production will not single handed be able to ensure global food security as we increase from 7 to 9-10 billion people.**

5. I.e. We need to invest in next generation feed systems capable of producing food independent of large land areas, massive input of artificial fertilizers and huge fresh water resources.

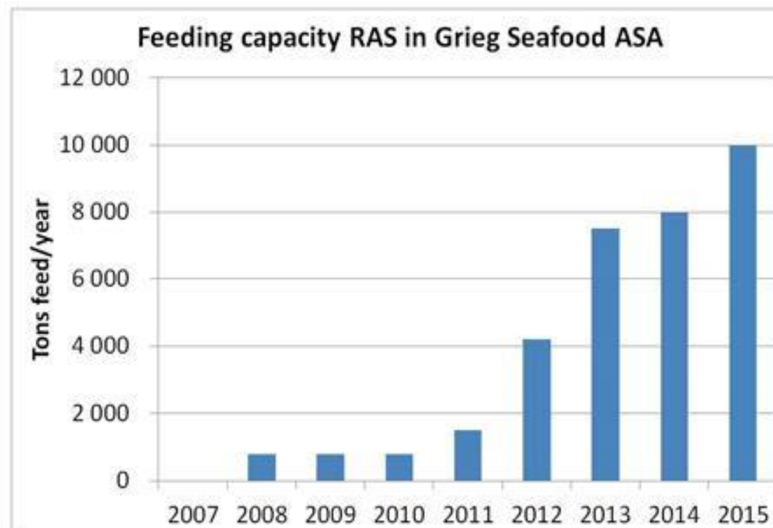
1. WE need to go from less to more control of our food production.

Photo courtesy of A[illegible]

This is already happening and the reason is increased control of:

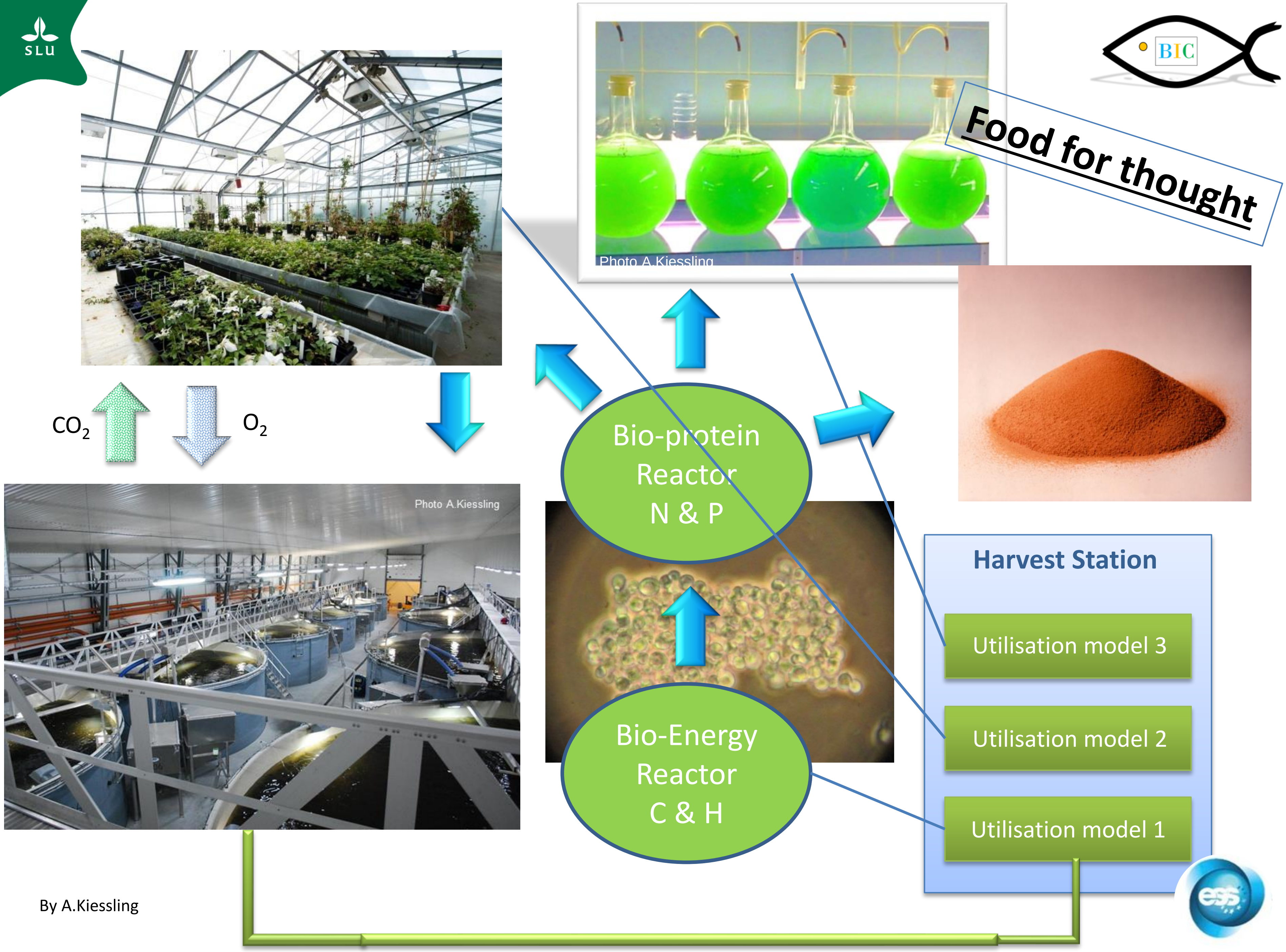
1. Temperature (production time)
2. Infectious diseases/parasites
3. Feed use / feed waste / effluents.

The use of RAS in Grieg Seafood ASA is illustrative for the general RAS development



By Frode Mathisen

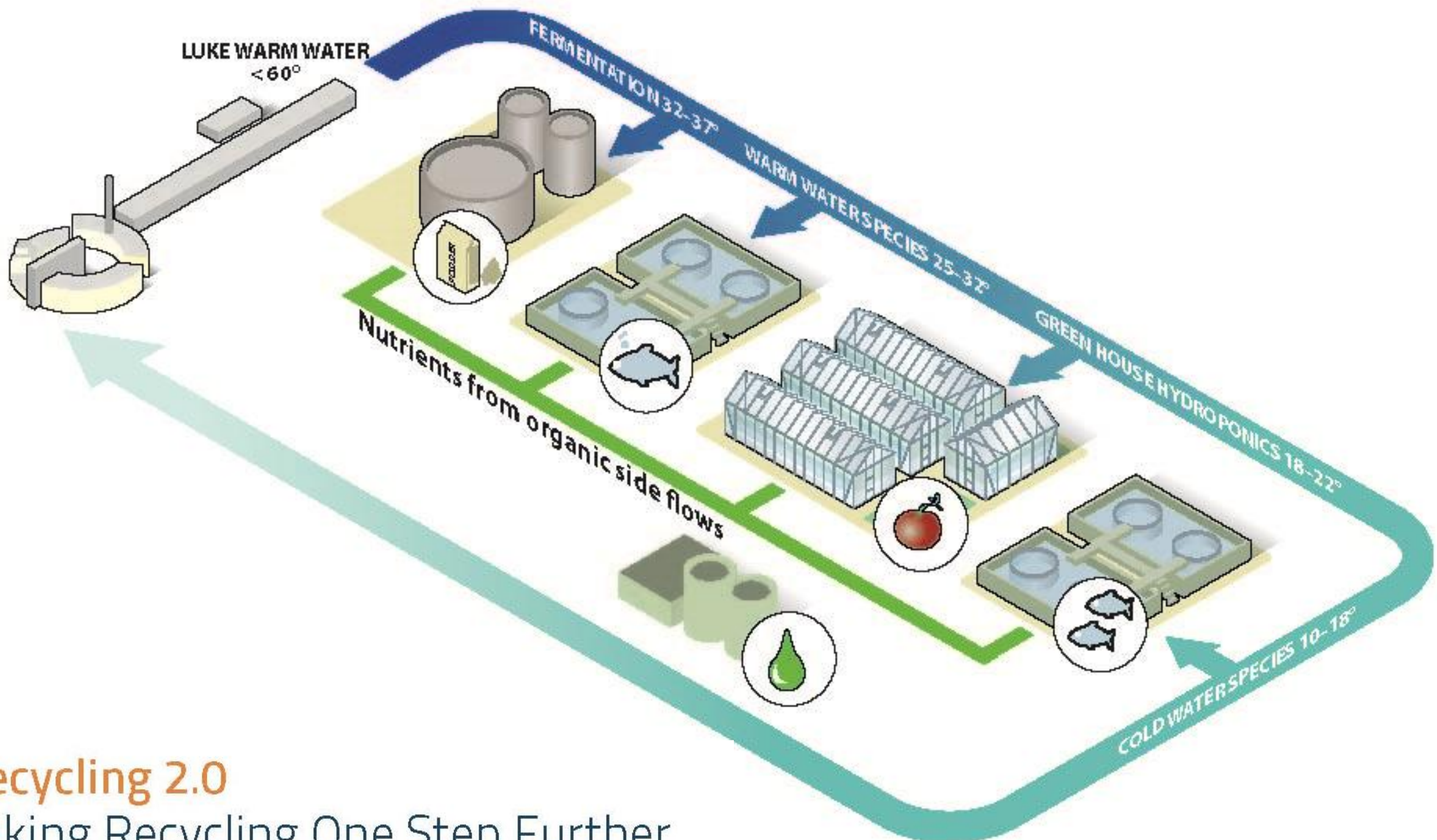
But we are only in the beginning of this development.



Food for thought
Photo A.Kiessling
CO_2
O_2
Photo A.Kiessling
Bio-protein Reactor N & P
Bio-Energy Reactor C & H
Harvest Station
Utilisation model 3
Utilisation model 2
Utilisation model 1
By A.Kiessling

Surplus energy and food production.

Thanks for your attention



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