# Nutrition strategies and Biofloc systems for shrimp

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# *Consulting for aquafeed production and formulation*

Feasibility studies for feedmill projects
Raw material sourcing
Formulation assistance
Raw material development
Supply of concentrates
Production of shrimnp feeds without marine proteins

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# *Consulting for Shrimp farming*

Feasibility studies (technical and economic)
Mainly for intensive farms with biofloc technology
Concept design
Feed management (recycling of nutrients)
Water quality management (min. effluents)

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# *Contract Feed Research*

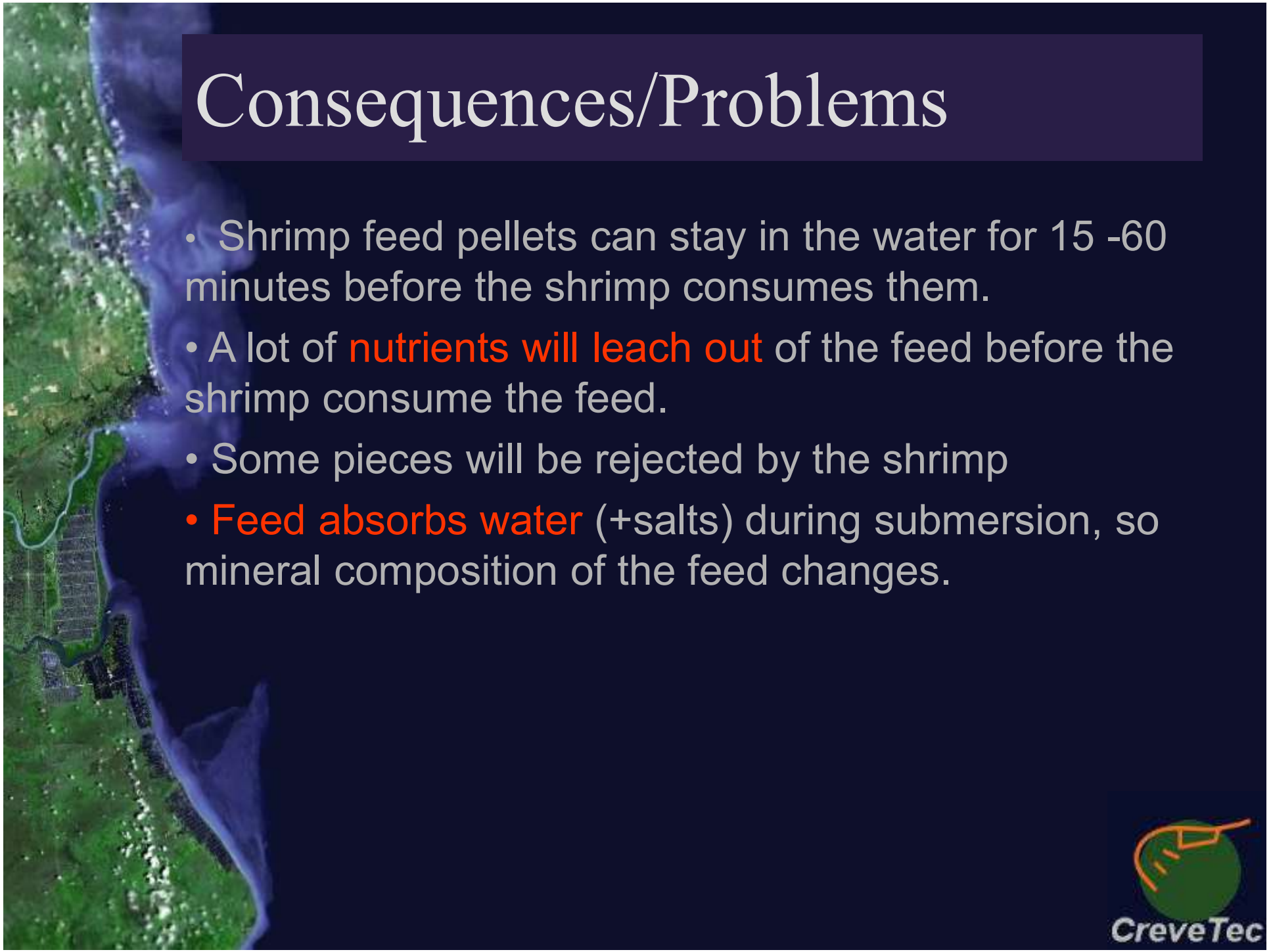
Concept of study
Production of small test batches
Feed trial
Digestibility, leaching studies,
Atractability and palatability studies

# Main differences between fish and shrimp feeds

- Shrimp are benthic
- Shrimp must find the feed by chemical attraction (leaching of nutrients)
- Shrimp are selective feeders, knibbling on pellets and only consume more feed when palatability is OK
- Shrimp are slow feeders

# **Shrimp** feeding

- Shrimp are external masticators, meaning that they chew their feed outside their mouth. They are selective feeders. They will nibble on it, select the palatable pieces and throw away whatever they don't like. The uneaten parts are left and will be digested on the pond bottom by bacteria.



# Consequences/Problems

- Shrimp feed pellets can stay in the water for 15 -60 minutes before the shrimp consumes them.
- A lot of nutrients will leach out of the feed before the shrimp consume the feed.
- Some pieces will be rejected by the shrimp
- Feed absorbs water (+salts) during submersion, so mineral composition of the feed changes.

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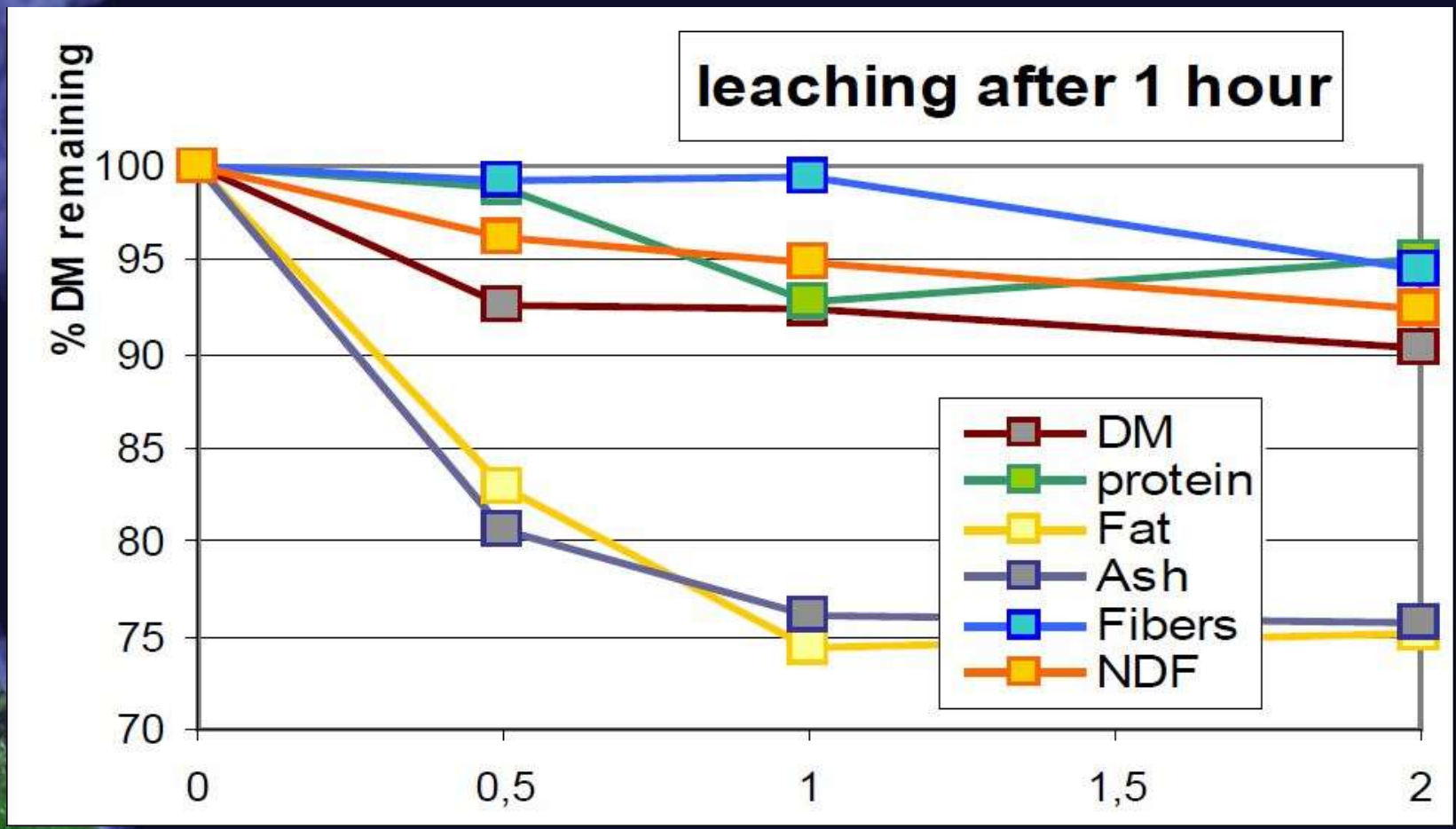
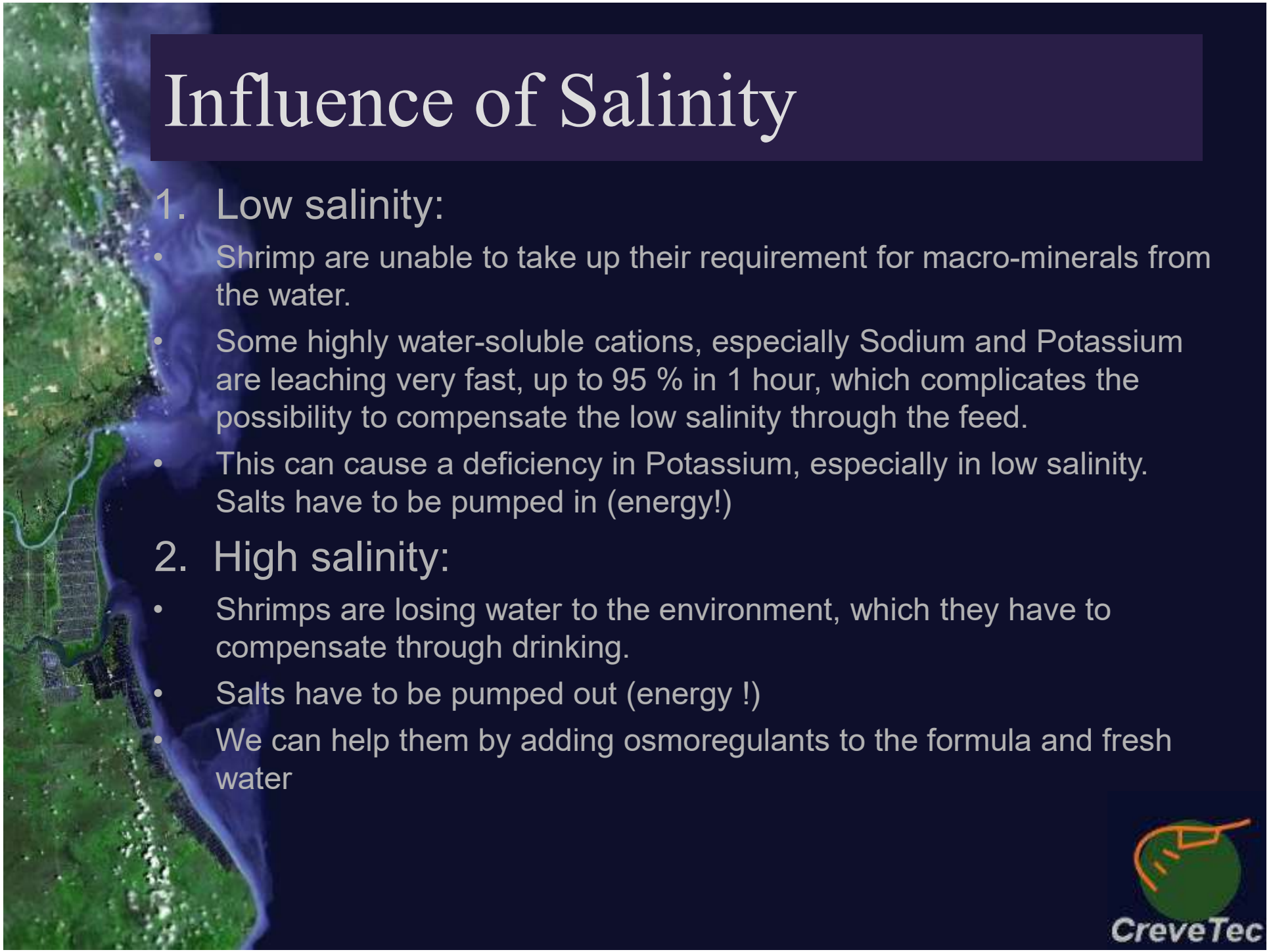
# Selective leaching of the main components





# Influence of Salinity

1. Low salinity:
   - Shrimp are unable to take up their requirement for macro-minerals from the water.
   - Some highly water-soluble cations, especially Sodium and Potassium are leaching very fast, up to 95 % in 1 hour, which complicates the possibility to compensate the low salinity through the feed.
   - This can cause a deficiency in Potassium, especially in low salinity. Salts have to be pumped in (energy!)
2. High salinity:
   - Shrimps are losing water to the environment, which they have to compensate through drinking.
   - Salts have to be pumped out (energy !)
   - We can help them by adding osmoregulants to the formula and fresh water

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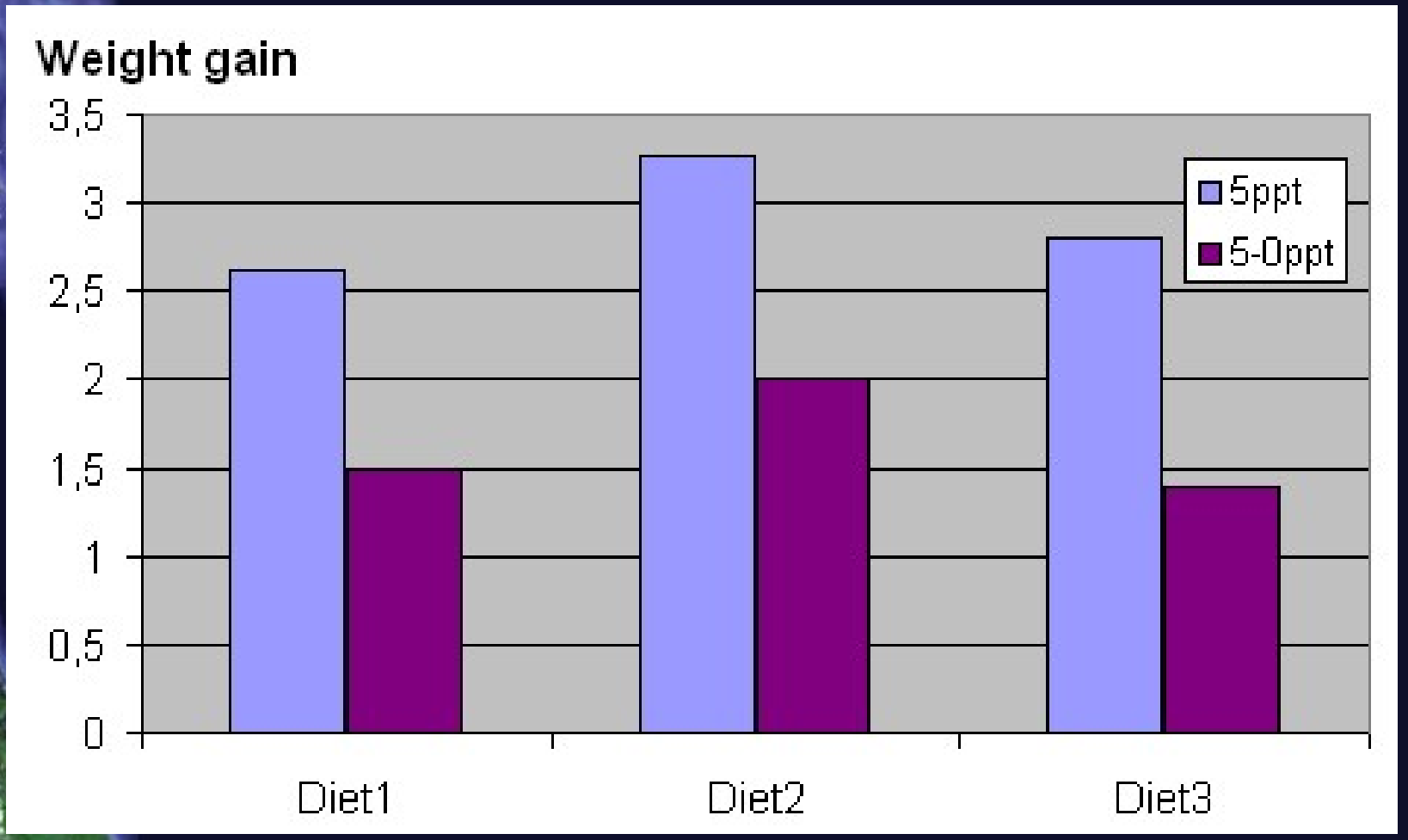
# Effect of diet and salinity on growth



# Feeding Frequency

- Shrimps are continuous intermittent feeders and hence should be fed several times throughout the day
- Shrimps need about 3 hours to digest, therefore, ideally, feeding should be done every 3 hours
- Frequent feeding of smaller rations also provides better efficiency in nutrient assimilation
- Feed will stay shorter in water so leaching of nutrients is reduced

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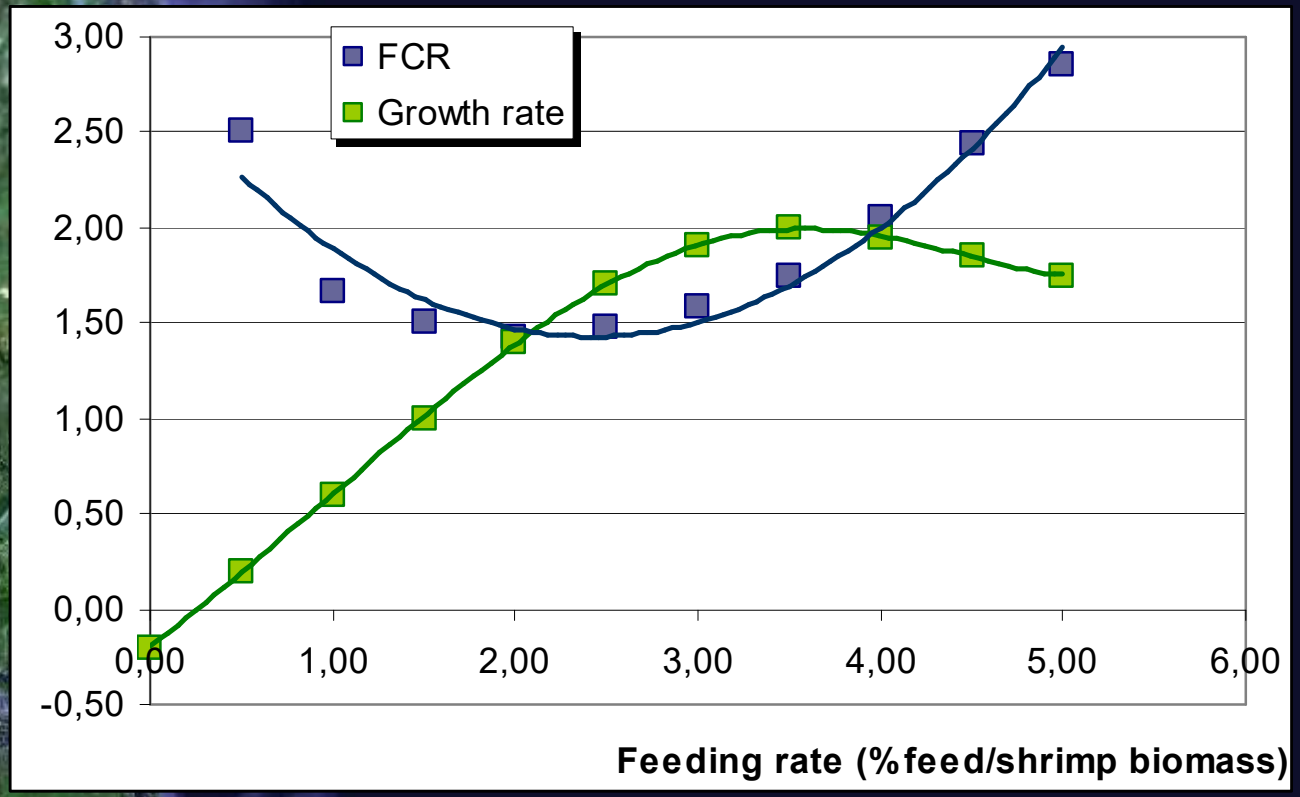
# Feeding Frequency

| | Feeding regime | Growth (g/week) | FCR |
|---|---|---|---|
| Week 1 | continuous | 1,67 | 1,46 |
| Week 2 | continuous | 1,74 | 1,03 |
| Week 3 | 4 times/day | 1,38 | 2,62 |
| Week 4 | 4 times/day | 1,14 | 3,75 |
| Week 5 | 2 times/day | 0,83 | 2,58 |
| Week 6 | 2 times/day | 0,99 | 4,59 |

# Feeding Rate




- No feed: growth loss
- Little feed for maintenance
- Lineair part leading to lowest FCR
- More feed for highest growth
- More feed: loss of growth due to pollution

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# Material & Methods - diets

A diet was formulated with not a single marine protein meal and compared with 3 traditional and proven formulations with 20 % Danish fish meal.

| | Diet WG | Diet PBP | Diet UF | No FM |
|---|---|---|---|---|
| ***Danish fish meal*** | **20** | **20** | **20** | |
| ***Corn Gluten*** | **11** | **11** | **12,5** | **12** |
| ***Soybean meal*** | **16** | **16** | **16** | **16** |
| ***Hemoglobin powder*** | | | | **6** |
| ***Wheat flour*** | **31** | **31** | **31** | **24,3** |

# Results: growth

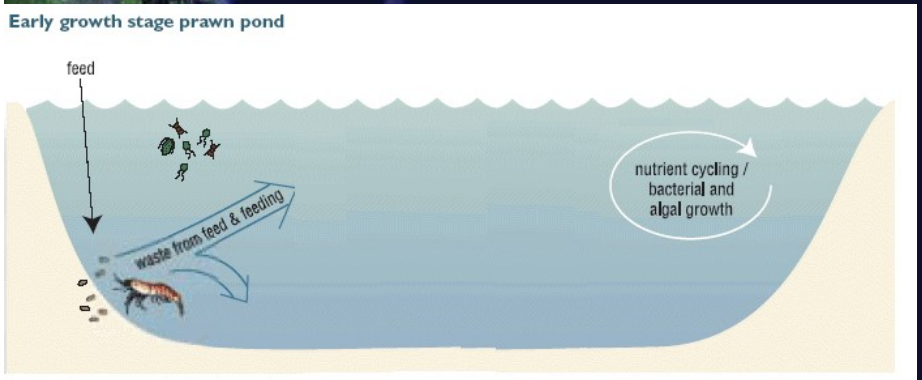
Shrimp showed a similar growth with all diets.
Although the shrimp with the diet without fish meal had a slightly better growth and FCR, these results were not statistically different.

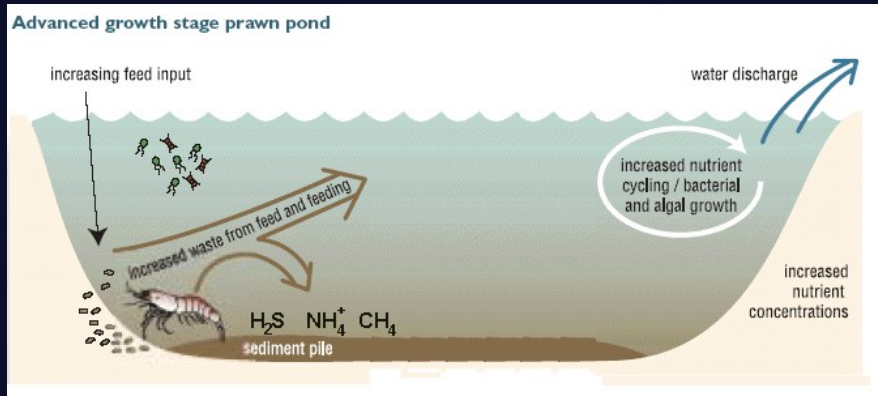
| | Diet WG | Diet PBP | Diet UF | No FM |
|---|---|---|---|---|
| *Initial ind. weight (g)* | *13,05* | *13,13* | *12,80* | *12,85* |
| *Final ind. weight (g)* | *22,44* | *22,7* | *22,09* | *22,63* |
| *Average growth (g/week)* | *1,565* | *1,595* | *1,550* | *1,629* |
| *FCR* | *1,81* | *1,60* | *1,66* | *1,44* |

# Shrimp feeding and water quality

- In nature, shrimp will consume a lot of pre-digested feed, like rotten fish and detritus. Whatever is not assimilated goes back to nature and is recycled. In ponds however, as density of production increased, these excess nutrients became pollutants, using oxygen and degrading into ammonia, hydrogen sulfide and methane, all toxic to shrimp. To get rid of those pollutants, water is exchanged and the pollutants are flushed out of the system.

- Feed conversions in shrimp culture are horribly high and don't show any progress.



# Biofocs are natural feed

Production of shrimp without water exchange with the utilization of bioflocs has gained a lot of interest recently. The presence of bioflocs in the shrimp farming system not only maintains a good water quality, but will also provide essential and high quality nutrients to the shrimp. This additional feed makes it possible to obtain fast growth and low FCR.

# Different strategies in Biofloc culture

Shrimp are able to cope with biofloc (suspended solids in water)
However, the conversion of ammonia into biofloc proteins results in a build-up of bioflocs. This process requires an energy source (carbon) and lots of aeration (electricity). But at the end, there are too much bioflocs in the system for the shrimp.
If carbon is less available, the bioflocs start to nitrify the ammonia into nitrates, which accumulates into the culture tanks and reduces the possibility to re-use this water for future production cycles. This nitrification also decreases the pH, which makes it necessary to adjust pH regularly.

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# Mass balance in biofloc systems

Most shrimp biofloc systems use low protein feeds in combination with adding a carbon source to alter the C:N ratio to 10:1, or even 20:1. This enables the heterotrophic bacteria to grow fast and take all nitrogen from the water and faeces as building blocks for proteins. This process uses oxygen and results in a high biofloc production.


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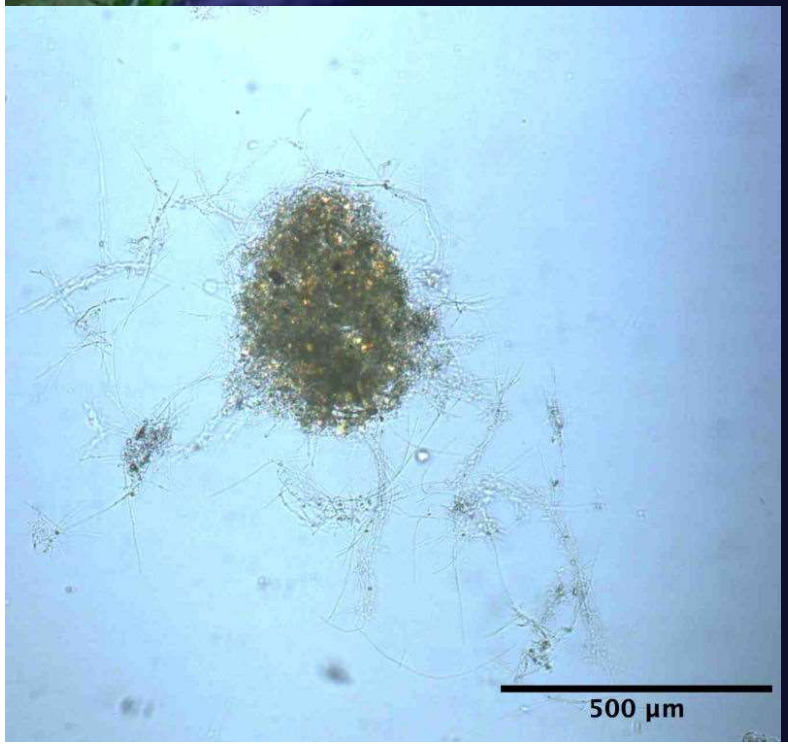
# Importance of C:N ratio ?

What happens if the C:N ratio is less than 10 ?
Bioflocs are very flexible and apart from heterotrophic bacteria will also contain nitrifying bacteria.
Nitrifying bacteria will oxydize part of the surplus TAN in nitrite and nitrate.




This process also requires oxygen.
It uses alkalinity and reduces the pH.
Result: accumulation of nitrates in the culture tanks and pH drop: $NaH_2CO_3$ has to be added to buffer the pH.

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# Inclusion of a bioreactor

Basically, excess bioflocs are used as energy source for denitrification

Advantages:
Control of biofloc density (reduction)
Always keep bioflocs in your system, even when shrimps are harvested
If you want to add sugar, you can do it in the reactor without risk of oxygen drop in the culture water
Nitrates are removed
Alkalinity is produced

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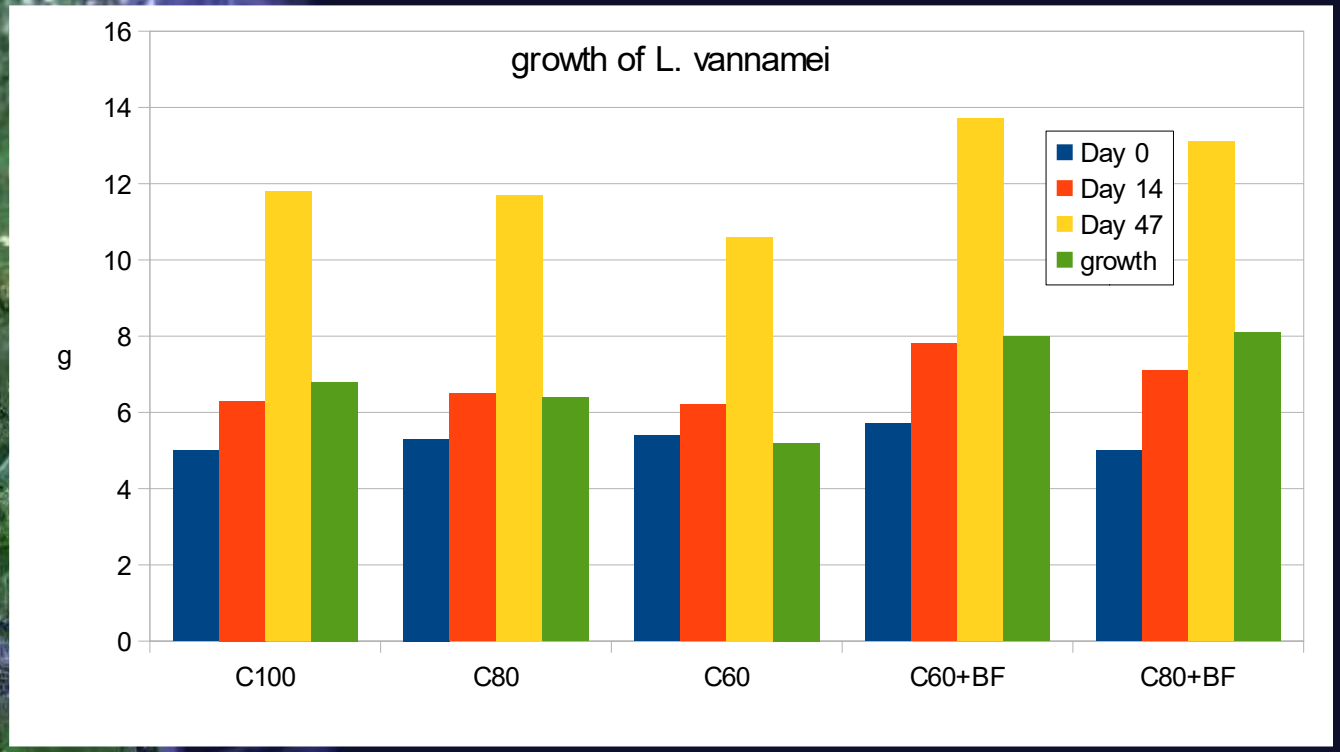
# Results – Growth experiment




C100: 100 % feed
C80: 80 % feed
C60: 60 % feed
+BF: bioflocs in water

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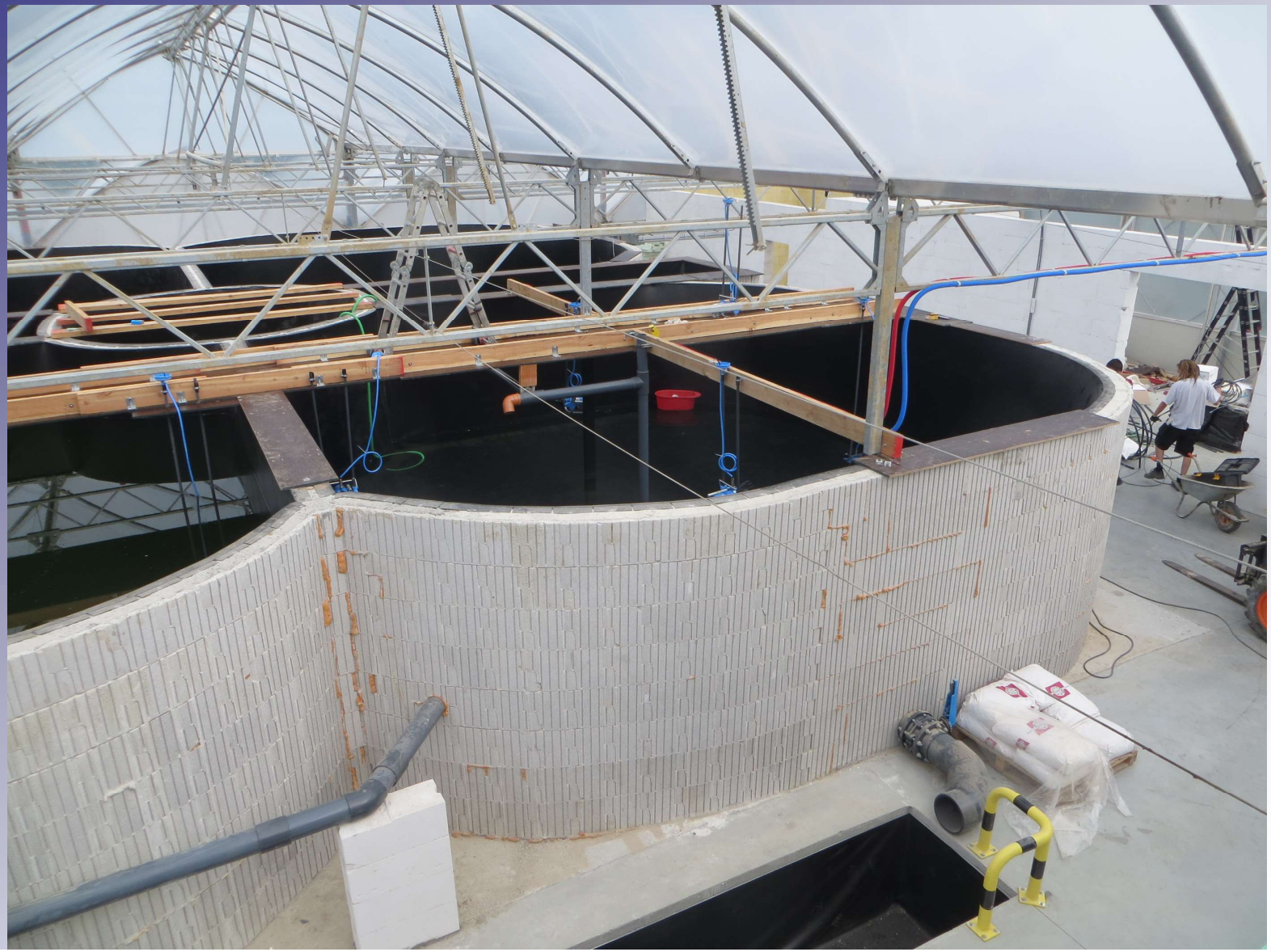
# Indoor farm Belgium



# CreveTope system

A Biotope for shrimp

3 phase growing to utilise the water volume :

- Nursery (PL11 - 0,5 g): 3-4 weeks
- Pregrowout (0,5 – 7 g): 6-8 weeks
- Growout (7 - 25g): 12-16 weeks

Central bioreactor enables complete recycling of water

Substrate habitats for shrimp

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# CreveTope system


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# Conclusion:
# Sustainable Production !

- No water exchange during farming
- Recuperation of water for next cycli
- Recycling nutrient faeces via bioflocs
- Limited utilisation of natural resources

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# Thank you !

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