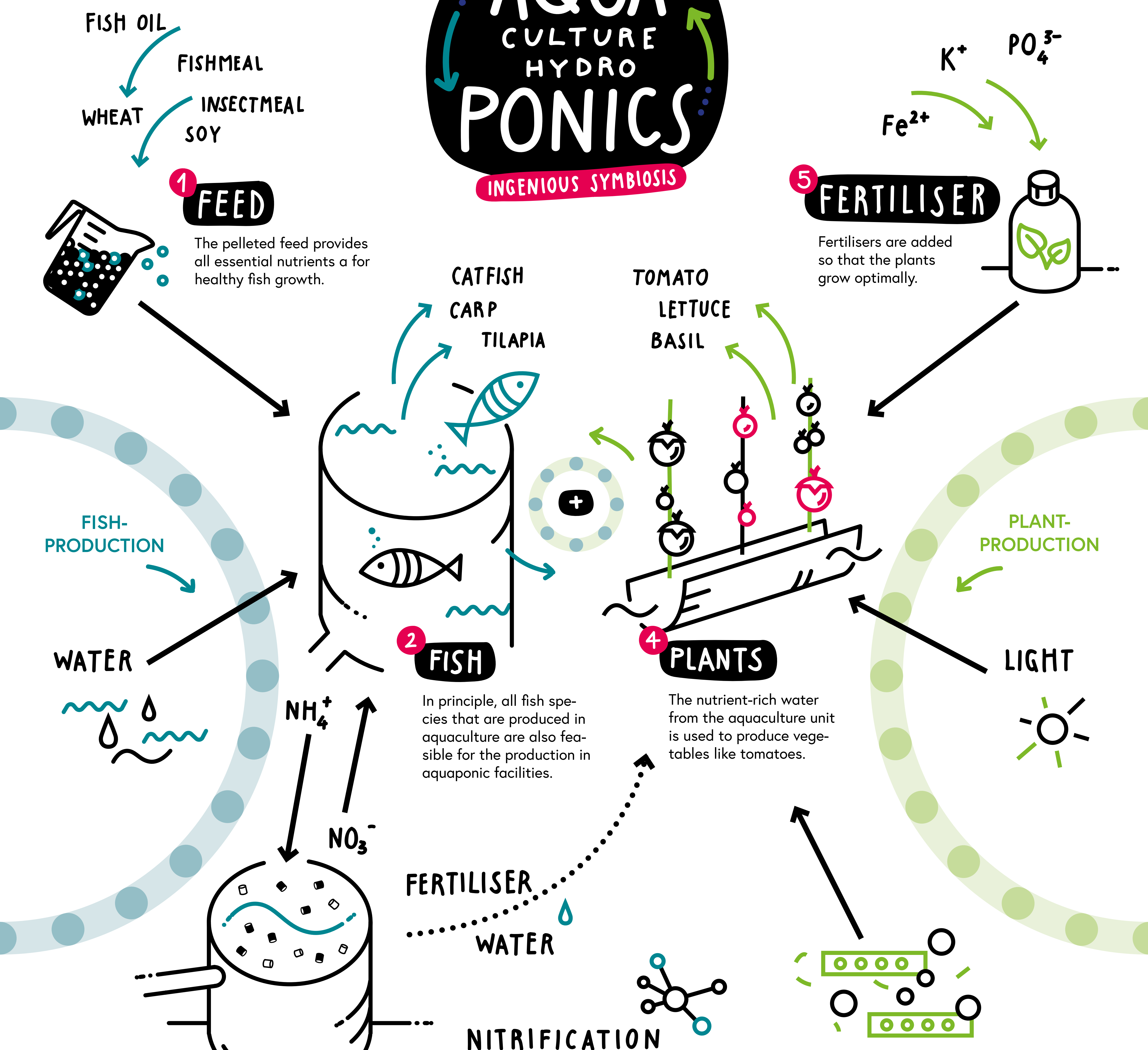
AQUA CULTURE HYDRO PONICS

INGENIOUS SYMBIOSIS



1 FEED

The pelleted feed provides all essential nutrients a for healthy fish growth.

5 FERTILISER

Fertilisers are added so that the plants grow optimally.

2 FISH

In principle, all fish species that are produced in aquaculture are also feasible for the production in aquaponic facilities.

4 PLANTS

The nutrient-rich water from the aquaculture unit is used to produce vegetables like tomatoes.

3 FILTER

In the biofilter Ammonium (NH_4^+), relased by the fish after feeding, is converted to nitrate (NO_3^-).

$NH_4^+ \rightarrow NO_2^- \rightarrow NO_3^-$ (FERTILISER)

A big part of the required fertiliser for plant production can be saved in aquaponics

6 SUBSTRATES

Different substrates (e.g. rock wool) are used in hydroponics to provide support for the roots of the plants

AQUA CULTURE

Aquaculture is the controlled production of aquatic organisms, such as fish, molluscs or crustaceans. Production can take place in open systems, such as ponds or net pens - but also in closed systems, in so-called recirculating aquaculture systems, which are a part of aquaponic systems.

AQUA PONICS

Aquaponics combines the rearing of fish in an aquaculture facility with the soilless cultivation of plants in a hydroponics system. By combining these two production systems, valuable resources, such as water and fertiliser can be saved.

HYDRO PONICS

Hydroponics describes the soilless cultivation of plants. In these systems, the roots are supplied with all important nutrients by a nutrient solution. The roots can either directly grow in the nutrient solution, be washed around or sprayed with a nutrient solution or even supplied by a hose and drip irrigation.

ENGLISH

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INGENIOUS SYMBIOSIS

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AQUAPONICS VR GAME

The main goal of the Aquaponic VR application is to make the complex biological and technical background of the integrated fish and plant production in an aquaponic facility accessible and touchable for a large number of user groups and the interested public through a virtual reality (VR) simulation.

Such tangible experiences can contribute to a better understanding and increase of the acceptance of these forms of production. However, such experiences are usually tied to a specific location and are only accessible in exceptional cases. With the help of VR technology, this can be transported in a realistic way.

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Leibniz-Institut für Gewässerökologie und Binnenfischerei

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AQUAKULTURINFO

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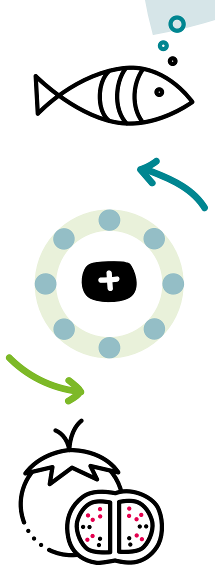

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By combining these two production systems, valuable resources, such as water and fertiliser, can be saved in plant production due to the dual use from the water in fish production.

Currently (2020) there are already around 7.8 billion people on earth and the United Nations (UN) are forecasting an increase to 9.7 billion by 2050. This is associated with increasing pressure on the ecosystems on land and under water due to the fact that more and more resources are needed for the creation of new living space or arable land, as well as for the production of food.

WHY AQUAPONICS?

Aquaponics is one of the most efficient food production systems when it comes to the consumption of water, feed and fertiliser, and space requirements. The yield per area is significantly higher compared to conventional production systems (for fish e.g. in ponds, for plants e.g. cultivation in soil on a field). Particularly with regard to advancing climate change, aquaponic systems could contribute to the fact that fewer resources and valuable arable land are available for food production.

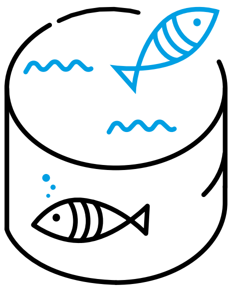
However, the investment costs for the construction of aquaponic systems are often high and the associated risk means that there are currently only a few commercial systems worldwide. In the hobby area, however, a large number of different systems can be found.

HOW IT WORKS

In aquaponic systems, fish are produced in closed recirculation systems. Due to the treatment of the water from the fish production with the help of mechanical and biological filters, these systems have very low water requirements. Thereby, nutrients, such as nitrate, potassium or calcium, are enriched in the process water.

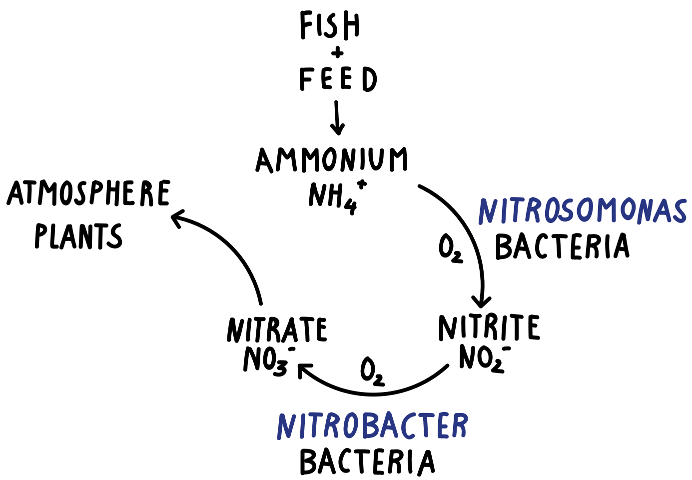
The nutrient-rich waste water, that is generated when cleaning the filters or when draining the water from the fish tanks, is usually disposed into the sewer system. In aquaponic systems, however, this enriched water is recycled by using it in the connected hydroponics unit (soilless cultivation of plants) for the production of plants, such as tomatoes, lettuce or herbs.

This saves nutrients and especially water and conserves natural resources in food production.



NUTRIENT CIRCLE

The fish feed contains proteins, carbohydrates and lipids that are required for the fish's metabolism (e.g. growth, energy production). When nitrogenous compounds are broken down, ammonium (NH_4^+) is formed as a metabolic end product and is primarily excreted through the gills. Depending on the pH, a part of the ammonium is present as fish-toxic ammonia (NH_3). The decomposition of uneaten feed and faeces (excrements) and their microbial degradation also increases the ammonium/ammonia content in the process water. The ammonium is converted into harmless nitrate via nitrite, as intermediate stage in recirculating systems by various biological filters, such as drip-, moving bed- or sand bed-filters, by certain types of nitrifying microorganisms. The conversion of ammonium to nitrite is done e.g. by the genus Nitrosomonas. The second step, the conversion of nitrite to nitrate, is e.g. carried out by the genus Nitrobacter.



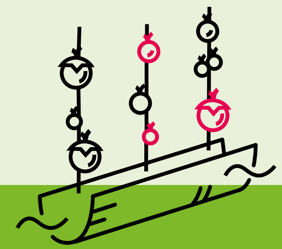
The formed nitrate represents the end product of the nitrification and consequently accumulates in the process water of the closed recirculation system.

FISH AND PLANTS

In aquaponics, fish species, such as Nile Tilapia, are produced. The natural habitat of these cichlids is Africa. As omnivores, they have lower demands on the feed quality. Additionally, they are robust against fluctuations in rearing conditions (temperature, nutrient content in the water, etc.) and grow rapidly.

Especially when rearing fish in greenhouses, the tolerance towards temperature fluctuations is a great advantage, as temperatures of over 30°C can be reached at times with intense sun exposure, but tight temperature regulation / air conditioning is very costly and not very sustainable. Other freshwater fish, such as African sharptooth catfish and various carp species, are successfully reared in aquaponic systems.

Cold water aquaponics is being tested in a few places (e.g. trout in Scandinavia). When selecting the plants, in principle all species that are grown in hydroponics can also be used for aquaponics. However, the specific nutrient requirements have to be considered. For example, fruit-bearing plants with a high nutrient demand, such as tomatoes, cucumbers or pumpkins, need significantly more nutrients than leafy plants, such as lettuce or herbs. Accordingly, in addition to economic aspects, the conditions of the respective aquaponic facility should also be taken into account when selecting the plants.



ECONOMIC IMPORTANCE

Currently (2020) there is still no widespread, commercial use of aquaponic systems for the sustainable production of food.

→ The main reasons are associated with high investment costs, inadequate standardization, the scarcity of trained staff and the associated risks when planning and financing such systems.

→ Several commercial systems have been set up in Europe in recent years. Today, there are a large number of small and medium-sized producers in the USA, who often produce on a sideline basis. However, there are no precise estimates on the global production volumes of aquaponic systems.

→ Compared to conventional systems, production can currently still be classified as extremely low.

→ Particularly promising for future commercial systems are decoupled aquaponic systems that enable optimal control of all production parameters and that were developed at the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB).