# Aquaponics

Aquaponics is an ecologically sustainable model that **combines** Hydroponics **with** Aquaculture.

Hydroponics is the soilless growing of plants, where soil is replaced with water. Aquaculture is the raising of fish.

- With Aquaponics **both fish and plants can grow in one integrated** ecosystem.
- The fish waste provides an **organic food source** for the plants, which in turn naturally **filter the water for the fish,** creating a balanced ecosystem.
  - The third participant i.e. **microbes or nitrifying bacteria** converts the ammonia from the fish waste into **nitrates** which plants need to grow.

## Benefits and Weaknesses of Aquaponics

The **Food and Agriculture Organization of the United Nations** (FAO) put out a technical paper in 2014, detailing the positives and negatives of the practice:

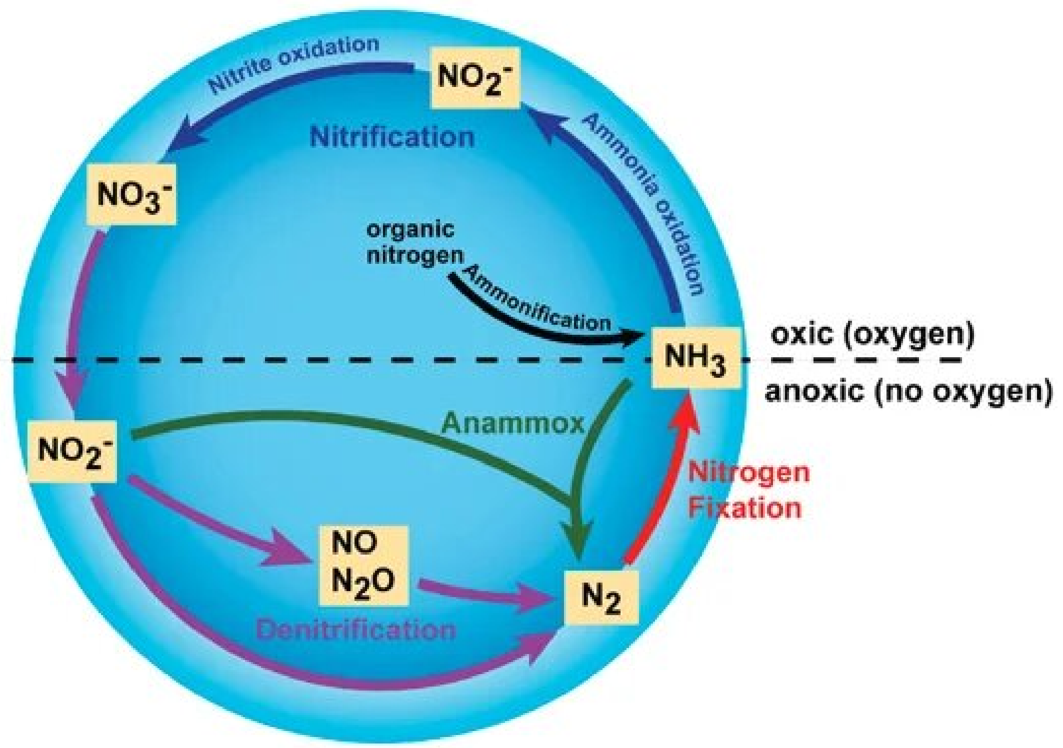
- **Benefits:**
  - Higher yields (20-25% more) and qualitative production.
  - Can be used on non-arable land such as deserts, degraded soil or salty, sandy islands.
  - Creates little waste.
  - Daily tasks, harvesting and planting are cut down to a great extent, thereby saving labour and time.
  - Both fish and plants can be used for consumption and income generation.
- **Weaknesses:**
  - Expensive initial startup costs compared with soil production or hydroponics.
  - Knowledge of fish, bacteria and plant production is needed.
  - Optimal temperature ranges needed (17-34°C).
  - Mistakes or accidents can cause catastrophic collapse of system.
  - Daily management is mandatory.
  - Requires reliable access to electricity, fish seed and plant seeds.
  - If used alone, aquaponics will not provide a complete diet

## Nitrogen Cycle

- Nitrogen is one of the **primary nutrients critical for the survival** of all living organisms.
- It is a **necessary component** of many biomolecules, including proteins, DNA, and chlorophyll.
- Although nitrogen is abundant in the atmosphere as **Nitrogen gas ($N_2$)**, it is largely inaccessible in this form to most organisms, making nitrogen a scarce resource and often limiting primary productivity in many ecosystems.
- Only when nitrogen is converted from Nitrogen gas into **ammonia ($NH_3$)** it becomes available to primary producers, such as plants.
- The major transformations of nitrogen gas are through the process of:
  - Nitrogen fixation (nitrogen gas to ammonia),
  - Nitrification (ammonia to nitrite and nitrate),
  - Denitrification (nitrate to nitrogen gases)

- The process of converting Nitrogen gas ($N_2$) into biologically available nitrogen, that is ammonia, by **nitrogen fixing microorganisms,** is called **nitrogen fixation.**
    - Some nitrogen-fixing organisms are **free-living,** while others are **symbiotic nitrogen-fixers,** which require a close association with the host to carry out the process.
    - Some of these bacteria are **aerobic, others are anaerobic;** some are **phototrophic, others are chemotrophic** (use chemicals as their energy source instead of light).
    - They all have a similar enzyme complex called **nitrogenase** that catalyzes the reduction of $N_2$ to $NH_3$ (ammonia).
- **Nitrification** is the process that converts ammonia to nitrite and then to nitrate.
    - Most nitrification occurs aerobically and there are two distinct steps of nitrification that are carried out by distinct types of microorganisms.
        - The first step is the **oxidation of ammonia to nitrite,** which is carried out by microbes known as **ammonia-oxidizers.**
        - The second step in nitrification is the **oxidation of nitrite ($NO_2$-) to nitrate ($NO_3$-).** This step is carried out by a completely separate group of prokaryotes (a unicellular organism), known as **nitrite-oxidizing bacteria.**

**Nitrogen Cycle**

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