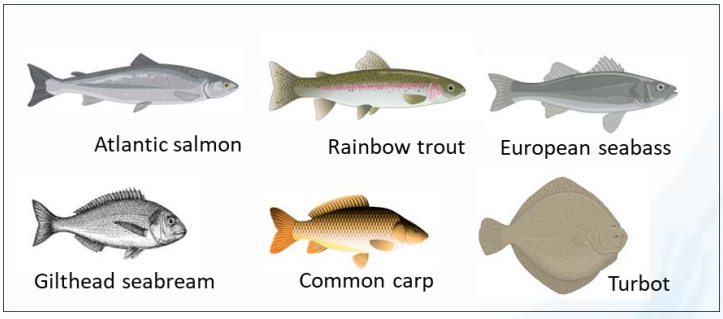
Precision breeding for more resilient and green aquaculture in the EU

AquaIMPACT - consortium. Coordinator: Antti Kause, Natural Resources Institute Finland (Luke).
AQUA-FAANG -consortium. Coordinator: Sigbjørn Lien, Norwegian University of Life Sciences.

Challenge

The European Union's aquaculture sector is a source of healthy food, fundamental to food security, and a major contributor to the globally increasing seafood consumption. Aquaculture faces formidable challenges in the form of imported seafood products and global disturbances. Concurrently, the industry must address its environmental impacts and animal health and welfare. Central to bolstering the sector's resilience has been the application of selective breeding and genomics, pivotal in advancing the sustainability of European aquaculture.

The revolution within the sequencing and genotyping industry has unveiled unprecedented opportunities for Research, Development, and Innovation (RDI) to usher in a new era of advanced precision breeding capable of addressing these challenges. The primary hurdle we face is the effective transformation of the substantial volume of genomic data into the next-generation computational genetics and bioinformatics methodologies and competencies essential for implementing selective breeding strategies, ensuring that both small and large enterprises across the European Union can adapt and thrive.



Goal

The goal is to develop next generation utilization of genomics data across aquaculture species in the EU for both simple low-cost breeding as well as for high-tech breeding companies, to enhance the sustainability and resilience of EU aquaculture, and to facilitate the transition to greener production methods.

Actions

Ensure support and resources to:

- ✓ Develop high-level expertise, RDI actions and capacity building both at academia and businesses that capture the new potential of aquaculture selective breeding and genomics. This requires dialogue both from the bottom-up (companies and researchers to EU visions and strategies) and top-down (policymakers to EU visions and strategies).

- ✓ Establish RDI program to develop precise aquaculture breeding programmes that more accurately identify the genetically superior individuals via computational genetic, bioinformatics and genotyping technologies, by taking into account the mode of inheritance, structural variation within genome and functional DNA variants influencing traits of relevance to the industry.

- ✓ Identify the genetic mechanisms and novel traits that underly production stability, nutrient and resource efficiency, disease resistance, and animal health and welfare in the face of challenges of climate change and across multiple production environments (sea, freshwater, on-land, recircular aquaculture system RAS, and their combinations).

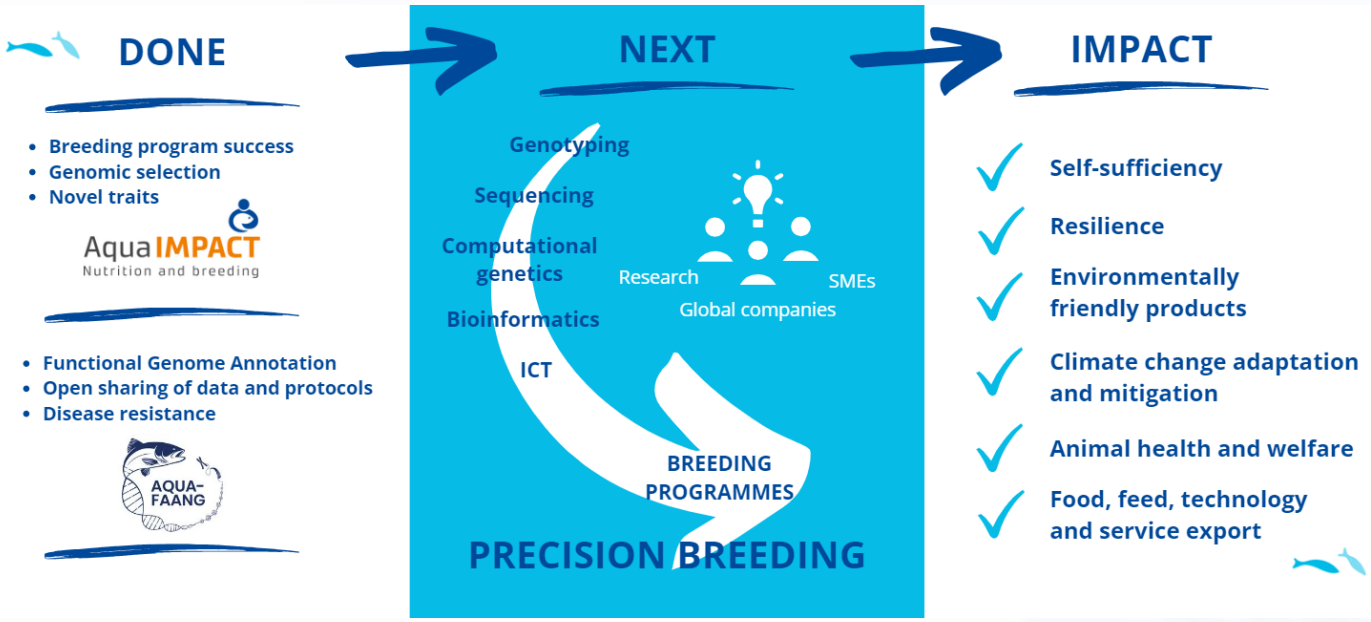
- ✓ Communicate the use of responsible and sustainable breeding methods and approaches that best and most effectively deliver the traits desired.

Impact

The EU's aquaculture sector becomes more competitive and sustainable, capable of withstanding disruptions both domestically and in global markets. This transformation leads to the growth of stronger EU-based companies, including technology exporters. These companies are empowered by a thriving educational and innovative ecosystem that stands as a global leader in pioneering novel genomics and selective breeding methods.

With the novel methods, the EU aquaculture industry can better tackle:

- ✓ **The megatrend of increased seafood consumption.** Seafood consumption increases globally, and this megatrend should be supported to maintain self-sufficiency in the EU.
- ✓ **Need for RDI in high tech.** Aquaculture nowadays has become a high-tech sector which requires specialised expertise in high-tech, digitalisation, ICT, biotechnology, breeding and genomics, and computational sciences. Besides the aquaculture species, these technologies themselves are export products and services.
- ✓ **More environmentally friendly production and climate change.** There is a need to make aquaculture less energy-demanding and more resource-efficient with reduced impact on the environment.
- ✓ **High animal welfare standards**. There is an increasing interest from both industry and citizens to increase fish health and welfare in aquaculture and to reduce the use of antibiotics.



AquaIMPACT **EU-project has shown that:**

Breeding programmes based on traditional pedigrees in Atlantic salmon, rainbow trout, gilthead sea bream and European sea bass have successfully improved fish traits and made the industry more sustainable.

Genomic selection that is based on the use of natural variation in thousands of DNA markers is more effective than traditional breeding and can be applied in industry settings to breed for novel traits such as disease resistance, feed efficiency, product quality, fish health traits, and resilience.

Statistical modelling of the mode of inheritance of fish traits in genomic evaluations makes the use of genomic information more precise, yet this is still a black-box breeding without precise knowledge of the biological functions of the genomic regions.

Current breeding programmes generate enormous amounts of genotype and sequencing data that could be utilised more effectively using novel computational and bioinformatics methods.

AQUA-FAANG **EU-project has shown that:**

AQUA-FAANG extends the contributions of AquaIMPACT with its comprehensive datasets, creating a significant impact on precision breeding and the sustainable development of European aquaculture.

AQUA-FAANG has identified functional regions in the genetic code (genome sequence) that significantly impact biological traits, including disease resistance, in major finfish species cultivated in European aquaculture.

AQUA-FAANG data allows to prioritize genetic variants likely to influence target species' traits, allowing to develop new genetic tools and approaches for breeding with improved accuracy without significant financial costs.

AQUA-FAANG shares all its data openly, enabling researchers and industry to scan the genome of each target species to identify functional regions of interest. This encourages global collaboration and innovation in precision breeding techniques.

These results together imply that as the next step, there is a need for the next generation utilisation of genomics data in the form of precision breeding.