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# Innovation opportunities in European Aquaculture

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# Introduction

Market forces will continue to drive the growth of European aquaculture as the only viable (capture fishing levels remain at over capacity) means to meet the demand for an increased fish supply. However, meeting this growing demand in a sustainable way that contributes towards [healthy diets](#), meeting the [Sustainable Development Goals](#) and works towards achieving [Net zero](#) is a challenge (Willett et al. 2019). With aquaculture growth across Europe (1-3% per annum, FAO 2020) lagging behind the rest of the world and with the challenges mentioned above, there is a clear need for innovation within the European aquaculture industry.

This review has identified five key areas that are able to address the key challenges identified above:

- **Technologies to optimise farm management**
- **Emerging production systems and aquaculture species**
- **Digital marketplace, supply chain solutions, and collaboration platforms**
- **Alternative and sustainable raw materials for fish feed**
- **Technologies to detect and reduce diseases in hatcheries/farms**

These five areas of innovation were selected as part of a wider review of innovation opportunities, and after being evaluated against the following criteria: time to market, novelty, market impact, environmental sustainability, societal impact. While this is not an exhaustive list of innovation areas, it does provide a selection of relevant innovation opportunities that can contribute to sustainable aquaculture development.

## Technology area 1 - Technologies to optimise farm management

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The first technological innovation area to consider are solutions that optimise farm management and there has been an emphasis on this area by large aquaculture producers. This includes the automation of operations, gathering of data via sensors, imaging and satellites, and analysis of this data to inform decision making through machine learning and Artificial Intelligence. Specific examples include automated feeding systems (which can help reduce feed waste) and cage maintenance, sensors to detect fish numbers/biomass, and predictive modelling of fish growth. This innovation area also includes technologies to monitor and control environmental factors such as water quality and temperature, which are important for productivity, but also allow measuring of the impact of the aquaculture operation on the surrounding ecosystem.

These technologies can increase aquaculture efficiency by minimising inputs and losses. These innovations may require lower capital cost than other aquaculture innovations as they utilise existing cutting-edge technology and can be developed and deployed relatively quickly. The exception is robotics which in some instances, can require larger investments.

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We are one team, working together across sectors, people and geographies to drive positive change.

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We are determined to meet challenges with solutions and enable innovators to think and act beyond expectations.

## Technology area 2 - Emerging production systems and aquaculture species

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Emerging production systems and novel aquaculture species is an area that is seeing large private investments and is seen as a major area for future sustainable aquaculture production. Emerging production systems and species include: onshore aquaculture/[RAS](#), off shore and deep sea aquaculture, seaweed and bivalves (mussels, oysters, clams etc) high value finfish, and sea cucumbers.

While all of the innovation areas in this category have the potential to have major impacts on the market, sustainability and society, most involve very high capital costs and are not yet widely adopted, partially due to technical limitations and operating costs. The exception to this is seaweed and bivalve production systems. These require comparatively less capital expenditure and can have a net positive effect on the environment through the uptake of chemicals from the aquatic environment (Jones et al. 2019), and as such, can be considered as contributing to 'regenerative aquaculture' or [bioremediation](#). Other systems to consider are multitrophic aquaculture models and co-localisation with energy systems (such as offshore wind turbines). While these systems are highly sustainable, these systems could be harder to scale lessening their impact.

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## Technology area 3 - Digital marketplaces, supply chain solutions, and collaboration platforms

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One innovation area that can improve the efficiency of aquaculture post-harvest is the creation of smarter supply chain solutions and the digitisation and automation of certain tasks. By coordinating approaches across the supply chain, SMEs in particular can be more competitive and this can have a positive effect on local rural economies. Digital marketplaces can reduce food waste, increase access to fresh seafood, and reduce the overall emissions associated with transportation. Tracking and tracing using technologies such as [block chain](#) allow retailers, consumers and regulators to understand the origins of the aquaculture product allowing more differentiation amongst aquaculture producers as well as presenting opportunities for more efficient cross border trade. It also allows for better reporting of environmentally sustainable practices to buyers. Because of this, novel tracking and tracing solutions will increase market confidence and contribute towards positive public perception. This can lead to safer, healthier and higher quality food systems.

Moving away from digital supply chain solutions, there is also an opportunity for collaborative processing and distribution centres to add efficiency and profit to aquaculture operations. By locating this infrastructure nearer to the operations, complexity can be reduced within the supply chain and local communities can be empowered to have a voice in the steps following harvest. This is likely to have a high impact overall but requires both a larger capital investment as well as 'buy in' from participating aquaculture operations.

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## Technology area 4 - Alternative and sustainable raw materials for fish feed

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Arguably one of the deleterious environmentally sustainable practices in the aquaculture industry is aquaculture feed production. This is due to the need to include protein in aquaculture feed, with 12% of global wild fish catch used as fish feed, and an increasing volume of soy (FAO 2018). A significant cost to aquaculture producers is the cost of feed, so developing more economical solutions that also develop a new industry could have high market and societal impact as new jobs are created, and current waste streams can also be utilised as part of the process.

Using alternative protein sources for aquafeed could lower the environmental impact of aquaculture, potentially be a more cost-effective source of feed increasing competitiveness and promote the growth of a novel feed source industry. Alternative protein feed sources such as insect meal are not especially new, [but recent funding in this sector](#) is bringing it nearer to market readiness. A good example of this would be a [new initiative](#) launched by Cargill (a leading feed producer) to help salmon farmers reduce their environmental footprint by 30 percent by 2030. Other sources of feed such as algal/seaweed merit further development as [seaweed production](#) is a growing industry and has many additional benefits outlined above under technology area 2.

[Industrial biotechnology-based feeds](#) are another novel area that could be explored and although this was not explicitly mentioned in any of the strategic reports that were analysed, was a targeted area for investment accelerators and funders. An example of this type of feed is the growth of single celled organisms on waste methane to create a sustainable protein source for aquaculture feeds.

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## Technology area 5 - Technologies to detect and reduce disease in hatcheries/farms

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Better animal health and welfare standards increase competitiveness by reducing costs and boosting yields, and also improve public perception of aquaculture. Several of these technologies and management systems can therefore have a high market impact on aquaculture, with some of these technologies being at the cutting edge of innovation. [DNA-based diagnostic technology](#) in combination with data reporting by smartphone and other pathogen detection technologies have the ability to improve disease detection and diagnosis and as stated lead to improvements in yields and reduced fish mortality.

Novel feed additives are another area that can improve production efficiencies as they can improve animal health and welfare. Diet formulation can have an impact on the absorption of feed and improve efficiencies through altering [fish gut biota](#) or enzyme additives. Feed composition and ingredients have other implications for the industry. Where ingredients are sourced (i.e. soy, fishmeal) will impact on environmental sustainability and public perception.

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The page features several thick, vibrant green curved lines that sweep across the background, creating a sense of movement and framing the text. One line starts from the top left and curves towards the bottom right. Another line starts from the top center and curves towards the bottom left. A third line starts from the top right and curves towards the bottom left. These lines intersect to form organic, leaf-like shapes.

## Conclusion

There are clearly many emerging areas of innovation within the European aquaculture sector and a focus on this sector could contribute significantly toward wider societal issues. Aquaculture is an important livelihood and contributes to human health and nutrition aligning well with many of the UN Sustainable Development Goals.

While growth in this industry has slowed in recent years, the increased political will to develop this industry coupled with the existing new innovations above could lead to a resurgence in aquaculture growth in the next decades.

At KTN our mission is to accelerate ambitious ideas into real-world solutions, and we are delighted that we are able to contribute towards achieving this in the aquaculture industry while also driving positive change.