

# TECHNOLOGY PLAYS IN AQUACULTURE

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Since 1960, global demand for seafood has increased 3.2 percent annually, outpacing the 1 percent annual growth in the world's population over the same period. Per capita consumption of seafood during this period has increased from 10 kg to over 20 kg today<sup>1</sup>. Overall demand for seafood protein is driven by demand in developing markets, particularly in Asia where fish has historically been a traditional source of protein in the diet, and in developed markets, due to the trend toward healthy lifestyles. Given the restrictions on wild catch fisheries due to depleting wild fish populations, production of fish and seafood protein in farmed systems has increased substantially over the past decade to address the increasing demand. The 8 percent growth in aquaculture production since 2010 is dramatic compared to the growth in production of land-based food animals (poultry, swine, and cattle).

## NORWAY'S SALMON INDUSTRY

### A MODEL FOR LEVERAGING TECHNOLOGY

To meet this growing demand, the aquaculture industry is investing in the development and adoption of new technologies that will dramatically transform how fish and seafood protein are produced sustainably. The development of the Norwegian salmon industry is recognized as a model for how new technologies can be leveraged to meet growing demand. Starting as a small-scale industry in the 1960s, the Norwegian salmon industry has emerged over the past 50 years as a world-class producer of salmon, with operations extending from Scandinavia to Chile, Scotland, Canada, and the Faroe Islands that together export over 1 million metric tons<sup>2</sup> of salmon products annually. This success was built on innovations in breeding (genetics), management systems, health products, and novel technology for production systems.



Technology clusters in Norway have developed solutions for addressing the limitations of oxygen in production systems, feed distribution, and disease control and treatment to increase the scale and efficiency of production sites. The industry also has shifted from using wooden cages to the current industry standard of polyethylene (PE) cages in open water, and is now beginning to adopt hinged-steel cages. Furthermore, new cage designs have allowed for the circumference of cages to increase from 60 meters to 160 meters, resulting in a 10-fold increase in production capacity for raising salmon in a single site<sup>3</sup>.

As the salmon sector has grown, investment in R&D and new technologies has not been limited to addressing production capacity issues but also has focused on enhancing biosecurity capabilities (reduction of bio-fouling), improving feeding technology (design of open water feeding barges managed by remote control), enhancing fish welfare (control of parasites), improving gentle fish handling, and ensuring environmental stewardship. The industry has focused on integrating knowledge between three core areas: the physical equipment (design and materials) used to farm seafood; operating systems leveraged to produce seafood; and intelligent management systems employed for coordinating the entire production system.

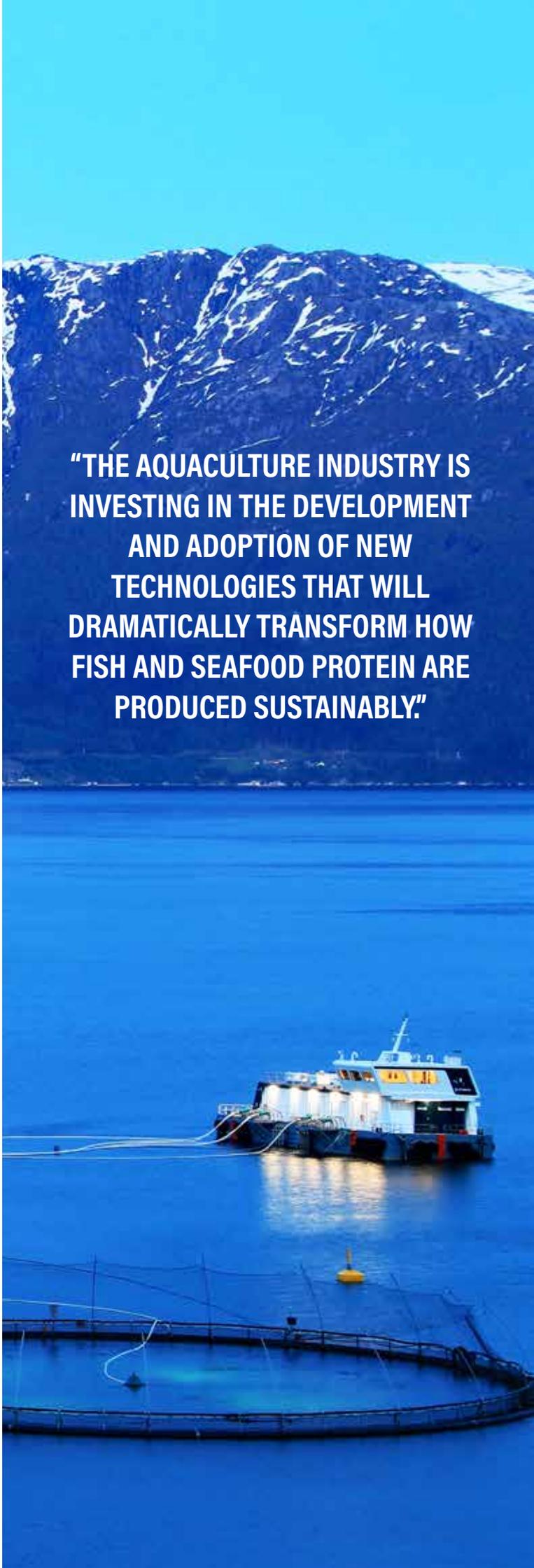
**“SINCE 1960, GLOBAL DEMAND FOR SEAFOOD HAS INCREASED 3.2 PERCENT ANNUALLY, OUTPACING THE 1 PERCENT ANNUAL GROWTH IN THE WORLD’S POPULATION OVER THE SAME PERIOD.”**

## OPPORTUNITIES FOR LEVERAGING TECHNOLOGY TO INCREASE SEAFOOD PRODUCTION

The model used to increase the scale and long-term sustainability of Norwegian salmon production is now being adopted to increase the production of other species of both marine and inland freshwater fish, shrimp, and mollusks. At the same time, new technologies are being developed to increase aquaculture production in land-based, closed loop systems that also address sustainability concerns by locating production closer to consumers, and lessening environmental pressures on coastal waters. An example of the latter is Atlantic Sapphire which has developed scalable land-based RAS (Recirculating Aquaculture Systems) systems in Denmark to produce what it claims to be the world's first sustainable Atlantic salmon brand and has purportedly raised funds to build a large-scale RAS facility in Miami, Florida, to produce salmon for the U.S. market.

To date, a majority of investments in technology ventures supporting aquaculture have been made in developing novel feed ingredients. This trend has been driven by two factors: first, the increasing scarcity of fish meal – a traditional source of protein and oil for carnivorous marine species such as salmon – has created an economic incentive to find cheaper substitutes; second, there is a perception among investors that investing in nutrition is less risky than investing in other ancillary sectors supporting the aquaculture industry. A number of companies are engaged in identifying and commercializing innovative ingredients derived from insects, algae, and single cell proteins to produce analogues for fish meal protein and fish oil (DHA), as industry experts concur that algal supplements currently being produced are too expensive to be used as a substitute. "There is still no viable economic substitute for the incorporation of fish oils in fish diets on a 1:1 replacement ratio," according to Steve Hart, vice president of the Global Aquaculture Alliance, an international non-governmental organization dedicated to advocacy, education, and leadership in responsible aquaculture. "Pressure is increasing to find solutions as Omega-3 levels in salmon have topped out due to decreasing inclusion rates of fish meal and fish oil in the diet."

Developing value-added soybean derived ingredients represents a promising area for atypical feed ingredients, and more importantly could ensure the long-term sustainability of aquaculture production. Several companies have developed proprietary formulas for inoculating soybean meal to produce a fermented soy protein that is easily digested by fish species. Prairie AquaTech, based in Brookings, South Dakota, is raising funds to launch commercial production of fermented soybean meal to be used in fish diets. In addition, the Illinois Soybean Association (ISA) has invested funds from the soybean check-off program to conduct research on replacing fish meal in tuna diets with soybean protein concentrates ("SPC"). Field trials conducted in Panama have demonstrated that substituting fish meal in the diets of farm-raised yellowfin tuna with SPC has increased the feed conversion rate (FCR) dramatically from 28:1 to 4:1.<sup>4</sup> Adoption of this technology, in combination with the recently developed capability to produce viable tuna fingerlings in hatcheries, will enable the sustainable production of tuna in open cages versus the current practice of raising tuna in ranches, thereby reducing the pressure on wild populations.



**"THE AQUACULTURE INDUSTRY IS INVESTING IN THE DEVELOPMENT AND ADOPTION OF NEW TECHNOLOGIES THAT WILL DRAMATICALLY TRANSFORM HOW FISH AND SEAFOOD PROTEIN ARE PRODUCED SUSTAINABLY."**

Health is another area where technology is being harnessed to address production challenges in aquaculture. Investment is being made to develop vaccines to tackle bacterial infections and viruses that cause stress in concentrated fish populations, resulting in mortality and reduced productivity. Conditions such as sea lice infestation, SRS (Salmonid Rickettsial Syndrome), and ISA (Infectious Salmon Anaemia), which affect salmon, and EMS, which affects shrimp, represent major opportunities for companies and investors to develop new solutions for improving productivity. While some of the innovations will be developed by start-up ventures, much of the innovation in this sector will be driven by the major pharmaceutical companies such as Zoetis.

Developments in gene editing also hold promise for the aquaculture sector. Aqua Bounty, a company based in Canada, has received permission from the U.S. Federal Drug Administration (FDA) to produce and commercialize Atlantic salmon that has been genetically modified, which will reduce the time required to raise the fish for market from three years to 18 months. Yet, due to media and consumer concerns regarding genetically modified organisms (GMOs), this product does not seem to be well received by retailers and consumers in the U.S. New gene editing techniques such as TALENs and CRISPR/Cas9, which act as “molecular scissors” to precisely cut into DNA to remove genes and replace optimal genes from the same species, offer the opportunity to increase productivity in aquaculture production by reducing stress and increasing disease tolerance in fish species while avoiding concerns over the use of gene transfer between organisms. Recombinetics, a leader in the gene editing field, is using these techniques to address productivity issues across a number of food animal species including fish. “Genetic improvements in fish species, along with innovation in the development of novel sustainable feed ingredients will have a dramatic impact on assuring the long-term sustainability of aquaculture production,” according to Max Holtzman, formerly senior advisor to USDA Secretary Tom Vilsack and currently vice chairman of Capital Peak Asset Management, which has advised and invested in Recombinetics.

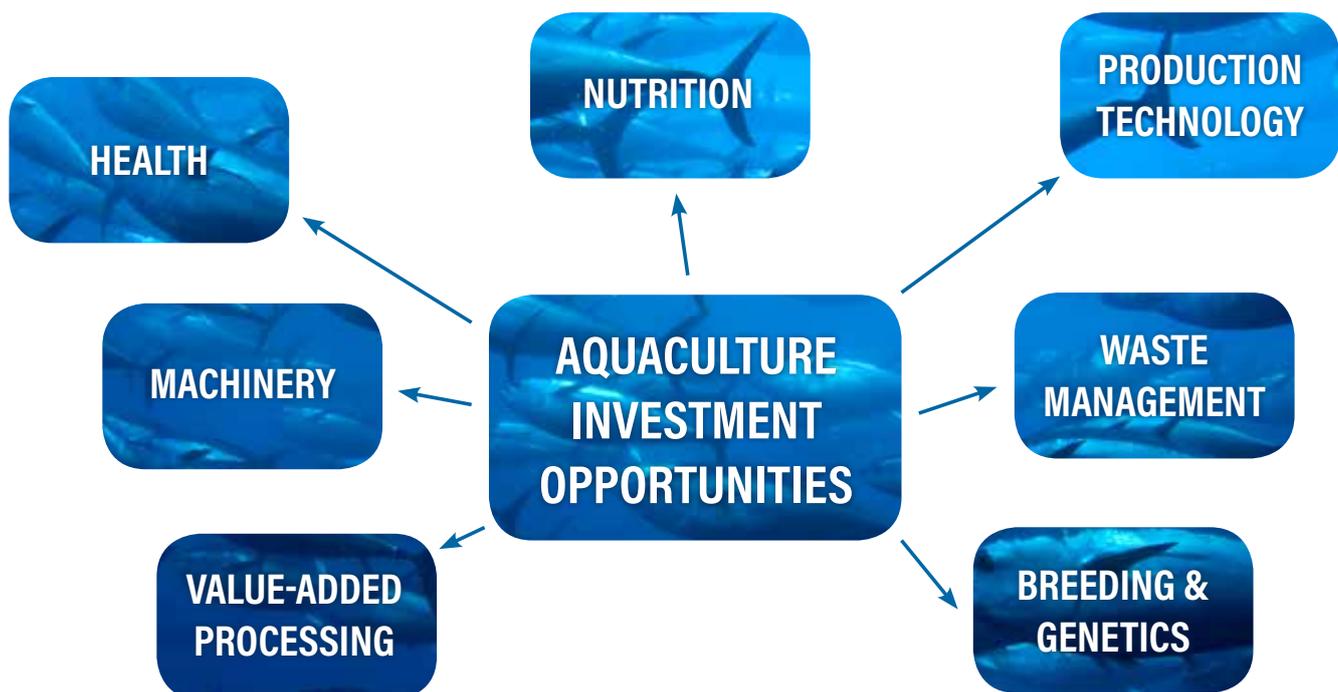
Dr. Francisco Saraiva Gomes, CEO of Pontos Aqua Holdings, a U.S. private equity firm investing globally in across the aquaculture value chain, believes that technology can be harnessed to reduce risks in production operations. “While the aquaculture sector is supported by strong secular trends, it is also subject to very high execution risk,” said Saraiva Gomes. “Aggressive deployment of technology both in production systems and in the supply chain can contribute significantly to the de-risking of an investment to ensure sustainable profits in what is a commoditized market.”

Finally, it is ironic that developments in e-commerce and logistics, rather than science, may have the greatest impact on the aquaculture industry by facilitating traceability in the supply chain. Both Hart and Holtzman see this as a major game-changer in the industry. “The Chinese market is well ahead of the curve on developing e-commerce strategies that respond to consumer preferences to order fresh and frozen seafood for home delivery from a preferred supplier who can confirm the species of fish, country origin, and the way it was raised,” noted Hart. “The Chinese market also is well ahead of the curve compared to how the market currently operates in the U.S.” Holtzman shared the same vision: “Traceability is going to become a major factor for establishing value for farmed seafood in the future. With 90 percent of seafood consumed in the U.S. imported and 50 percent of that produced on farms, the ability to guarantee origin and the way a fish was raised will become the accepted standard for the industry.”

### INVESTMENT OPPORTUNITIES

Given that the aquaculture industry is relatively nascent compared to other food animal production systems, there are many areas that investors can consider for investment. This spans from developing new feed ingredients to replacing declining supplies of fish meal, to developing new technologies or new genetic strains of fish or management production systems.

## OPPORTUNITIES FOR INVESTING IN AQUACULTURE



A representative list of companies engaged in developing innovative technologies for the aquaculture sector includes:

| Company          | Sector             | Focus  | Country      | Website   |
|------------------|--------------------|--|--------------|---|
| AgriProtein      | Nutrition          | Fly larvae used as a feed ingredient             | South Africa | <a href="http://agriprotein.com/">http://agriprotein.com/</a>             |
| AquaBounty       | Breeding/ Genetics | GMO salmon                                       | Canada       | <a href="http://aquabounty.com/">http://aquabounty.com/</a>               |
| KnipBio          | Nutrition          | Single-cell protein feed replacement             | USA          | <a href="https://www.knipbio.com/">https://www.knipbio.com/</a>           |
| Prairie AquaTech | Nutrition          | Fermented soybean meal used as a feed ingredient | USA          | <a href="https://prairieaquatech.com/">https://prairieaquatech.com/</a>   |
| Recombinetics    | Breeding/ Genetics | Gene editing                                     | USA          | <a href="http://www.recombinetics.com/">http://www.recombinetics.com/</a> |
| Ynsect           | Nutrition          | Mealworm protein used as a feed ingredient       | France       | <a href="https://www.ynsect.com/">https://www.ynsect.com/</a>             |

The following is a typical profile of an institutional investor interested in allocating capital to technology ventures serving the aquaculture sector:

Patient capital provider;

- Long term fundamental focus;
- Thematic investment mindset;
- Seeking inflation protection; and
- Believes in the "efficient protein" story.

Family offices, sovereign wealth funds, and endowments would be well-suited to consider investing in early-stage companies in the aquaculture sector whereas pensions funds and life insurance companies would be well suited to allocate capital to mature-stage investments in the sector which are in the growth stage.

## "FAMILY OFFICES, SOVEREIGN WEALTH FUNDS, AND ENDOWMENTS WOULD BE WELL-SUITED TO CONSIDER INVESTING IN EARLY-STAGE COMPANIES IN THE AQUACULTURE SECTOR..."

### SOURCES:

1. The State of World Fisheries and Aquaculture 2014. Food and Agriculture Organization of the United Nations (FAO). <http://www.fao.org/3/a-i3720e.pdf>.
2. "Norway Marine Aquaculture – Challenges and Opportunities." Presentation by Arne Fredheim, vice president projects SINTEF Fisheries and Aquaculture, at the Norway-Japan Marine Seminar, 2012.
3. Ibid.
4. "Soy-based diet boosts tuna aquaculture." FarmWeekNow.com. April 19, 2017. <http://farmweeknow.com/story-soy-based-diet-boosts-tuna-aquaculture-1-158543>.
5. FAOSTAT. Food and Agriculture Organization of the United Nations (FAO). <http://www.fao.org/faostat/en/#home>.
6. Ibid.
7. Ibid.

The positive trends in the aquaculture sector, which should attract capital over the foreseeable future, include:

- World population and GDP per capita growth (specifically in Asia where seafood is a traditional source of protein in the diet);
- Healthy and highly efficient source of seafood protein compared to land-based food animals;
- Resource depletion (reduced wild fish populations resulting in flat wild catch production trend);
- Increasing limitations of other sources of animal proteins (e.g. land and freshwater use, high feed conversion ratios, etc.);
- Good overall long-term growth expectations;
- Expectation of decoupling from economic cycles (efficient source of protein);
- Largest category of animal proteins produced annually (~150 million metric tons/year<sup>5</sup>);
- The most global of all animal protein categories with export value (> \$ 100 billion/year<sup>6</sup>);
- Aquaculture is the fastest growing animal protein category (+56 million metric tons/year<sup>7</sup>); and
- Relatively fragmented and less mature industry (poised for consolidation).

Investment in technology ventures that support the growth of aquaculture production promises to be an exciting area over the next decade for investors who are willing to take the time to educate themselves about the industry, and about what type of innovations will be the most transformative. 🌱

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