After a brief period of strong supply expansion in 2014, the global salmon industry is reverting to the 'high-cycle scenario’ already present since late 2012. This temporary, but unusually long-lasting, undersupply and high price environment is expected to remain for at least the coming two years. During this period, the salmon farming industry will focus strongly on biosecurity, sustainability, cost control, certification and technological innovations. We expect increased global demand to support the high price environment and the strong profitability of farmers. This expectation holds true, even with Russia’s ban on Norwegian and EU salmon, which will likely create large scale trade shifts and price volatility.

High-cycle conditions to persist

In a 2011 Rabobank report titled “Salmon Industry Shifts Gear”, we observed the likelihood of an unusually long period of undersupply and high prices (i.e. a prolonged high-cycle environment) following the booming salmon supply years of 2011 and 2012. Indeed, growth in 2013 was constrained to a mere 2.3 percent, but the first half of 2014 experienced unexpectedly strong supply growth. Consequently, the supply growth estimated for 2014 is a respectable 8 percent (see Figure 1). The reasons for strong growth are twofold. Like all fish, salmon are endothermic animals whose metabolism is closely linked to water temperature. The warm 2013/14 winter in the North Atlantic boosted the salmon’s appetite and growth rate, driving up the Norwegian harvest as well as that of the other North Atlantic producers. At the same time, due to a recovery in the sanitary conditions in Chile, lower mortalities and improving harvest weight provided an additional boost to supply. However, despite the strong growth in the first half of the year, our expectation is that the high cycle is here to stay for at least two more years. Legislative and biological constraints in both Norway and Chile are coinciding to limit further growth in supply and prolong the high price environment.

Figure 1: Global Atlantic salmon supply growth expected to decline, 2001-2017f

Source: Kontali, Rabobank, 2014
Norwegian industry nearing maximum capacity

Maximum allowable biomass is the main limiting factor to supply growth

In the last few years, the salmon farming industry in Norway has been gradually approaching the legal production limit, determined by the maximum allowable biomass (MAB) per licence. Roughly described, the MAB is a point-in-time measurement of the biomass of salmon in a single location. Nearly all Norwegian producers are now reaching this limit, especially during the late summer and early autumn months when the standing biomass is at a seasonal peak. For some time, the Norwegian industry and legislators have debated whether changing this legislation would allow growth in the sector. For instance, if the MAB was applied to an annual average rather than a single point in time, the industry could see additional expansion of roughly 12 percent to 15 percent within the existing licences. However, this decision carries with it the risk of a potential price crash due to a sudden supply growth. And more importantly, the higher biomass could cause a significant sanitary risk. The warm water that created the favourable environment for increased supply in 2014 is also favourable for salmon lice, a parasite responsible for major costs and productivity losses in the salmon industry. Moreover, salmon lice pose a potential threat to the wild salmon population. In view of the elevated sanitary risk and negative externalities, Norwegian regulators have chosen to reject this idea and to ensure that parasites and diseases are firmly under control before allowing the industry to expand.

Norwegian regulators have put forward a new proposal, though still with many unknowns, which would allow salmon farmers to buy a one-off 5 percent increase to the MAB, as long as lice numbers do not exceed 0.1 lice per fish (adult female lice) and as long as no more than two lice treatments are used per production cycle. The latter requirement is a precaution to ensure the lice do not develop resistance to the treatments. The limit of 0.1 lice per fish is far lower than the regulators’ current limit of 0.5 lice per fish. Although the average lice count per fish has shown a decline in the last few years, most fish still have between 0.2 and 0.3 lice for most of the year (see Figure 2). Moreover, due to the warm water environment, there has also been a noticeable increase in lice during 2014. Consequently, only a few salmon farmers located in the northern parts of Norway, possibly 15 percent to 25 percent of the industry, could apply for this extension in the short term. At that rate, the new law, if implemented, could at best create a supply increase of approximately 1 percent in 2015. Assuming lice numbers are indeed reduced, an additional 2 percent to 3 percent supply growth could occur under this new law in 2016 or 2017. However, growth would be considerably lower than under the rejected alternative to change the way the MAB is measured. Although the new regulation, on which the Norwegian parliament will take a vote in December 2014, has divided opinions among the Norwegian salmon farming industry and NGOs, investors have generally reacted positively.

Figure 2: Strict lice per fish limits in Norwegian legislation, 2010-2014

Source: Rabobank, Lucedata, 2014
Some growth from new green licences
Slightly more room for growth in Norwegian salmon production comes from the issuance of new ‘green’ licences. These licences are considered green because they require stricter environmental standards than conventional licences. The last issuing round was largely completed in mid-2014, but due to some appeals, a fraction of the remaining licences will be awarded in 2015. There are still a few unknowns, but the new green licences should provide additional supply of some 70,000 tonnes (approximately 5 percent growth), which will impact supply in 2016 and 2017. More importantly, no other new licences will be issued before 2017. It is clear that Norway is nearing the maximum production possible in the current legal environment.

Still a bit more left from existing licences
Although Norwegian salmon producers are close to the MAB limit, there is still some room for growth. In the past, the industry has shown inventive approaches to achieving additional production within the MAB (e.g. better husbandry skills, lower mortality and improving genetics). A more recent tactic is to improve the utilisation of the production licence by using larger smolt sizes (see box 4). A number of farmers have already made investments in hatcheries to significantly increase the size of the smolt. By focusing on larger smolt and increasing the MAB utilisation rate ever closer to 100 percent, the industry could see growth of approximately 1 percent to 2 percent per year, at least for the medium term.

Based on all the growth possibilities combined—purchasing the one-off 5 percent increase in the MAB limit, new green licences and the further increase in the utilisation of existing licences—Norwegian supply growth is expected to be in the range of 3 percent to 5 percent in the coming three years, provided there are no negative developments such as unusually poor biological conditions, environmental accidents or exceptionally cold weather. While this is a respectable level of growth, and much higher than the growth of the more mature animal protein industries, such as poultry or pork, it is considerably lower than the long-term average of 7 percent and much lower than the growth in 2014 (estimated at close to 9 percent) or in the record year 2012 when production was nearly 18 percent higher.

Chilean salmon industry changing gear

Biological improvements and supply growth slow-down
While constraints to Norwegian production are chiefly legislative, the limitations for growth in Chile’s salmon industry are primarily biological. In a recent report, Rabobank described the legislation that forced farmers experiencing poor biological performance to reduce farming density in the next production cycle. In part, this is the mirror image of the suggested 5 percent MAB increase in Norway, where good performance is rewarded with increasing farming density.

The Chilean industry has already been impacted by this legislation, with a few producers forced to reduce farming density, which will impact supply in 2015. However, the industry is currently only using 374 of the total 1,277 producer-owned seawater sites, called concessions. While this indicates capacity utilisation of only 30 percent, approximately one-third of the concessions are not suited for salmon farming, which means the industry is operating at a theoretical 50 percent capacity. It is important to emphasise that this is only a theoretical limit as there is a much lower, far harder to pinpoint, biological production capacity limit. The deterioration of the sanitary conditions during 2012 and 2013 along with increasing costs and the resulting financial losses for producers have ultimately been the main reasons for the slowdown in growth in the Chilean industry. Fortunately, the measures taken by producers and regulators have reversed the negative trend and biological performance has improved throughout 2014 (see Box 1). There is also a noticeable change in attitudes among producers themselves, as the experiences of the infectious salmon anaemia (ISA) crisis between 2008 and 2010 and the recent sanitary crisis of 2012 to 2014 have been valuable lessons. Producers have learned that increasing production volume will only lead to growth of profits if the laws of nature are respected and the sanitary conditions are optimal.

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1 See Chilean Salmon: New Regulations to Slow Growth (June 2013).
Box 1: Improving Chilean biological performance

The recent improvements to the cost structure of farmed salmon in Chile can be attributed to a variety of changes: (1) the new regulation focusing on biosecurity, (2) the strict implementation of legislation and good coordination by the producers, (3) more effective lice treatments, (4) the innovative closed-tent-bath method, which consternates the lice treatments, and (5) the more careful selection of sites, for instance, with deeper water. The recent mortality figures and other biological performance indicators such as harvest size are currently far better than those observed in 2012 and 2013 (see Figure 3). However, due to a long production cycle of close to two years, it will take at least one more year before the improved farming conditions take full effect on cost or production per kilogramme. We expect that the Chilean industry should be able to continue making improvements throughout 2014 and 2015.

Despite the recent improvements in the Chilean industry, it is clear that its two main salmon farming regions, Region X and Region IX, are approaching their natural biological production limits, at least with the current farming technology and legal framework. Innovations will gradually expand this limit, but the short and medium-term growth in these two regions will remain limited. The third and most southern Chilean region, Region XII, has excellent sanitary conditions and is where the industry can find the most incremental growth capacity. Moreover, as ownership of the licences in Region XII is consolidated, with single producers controlling large areas, coordination towards biosecurity will be easier to achieve. Currently, this region accounts for 10 percent of the Chilean Atlantic salmon biomass, but has the potential to treble its output while still maintaining low density of production. However, due to the lack of infrastructure, insufficient local labour, few hatcheries and currently high logistics costs, it will take years for the region to become a considerable driver of Chilean supply growth.

Although Chilean salmon production in 2013 expanded by 29 percent and could still expand by an estimated 9 percent to 11 percent in 2014, the next few years will see limited growth of no more than 1 percent to 5 percent per year. Assuming the good sanitary conditions and profitability remain, the Chilean industry could eventually emerge as the leading growth driver of global supply, but only in the long term.

Good demand in times of low supply growth will support salmon prices

Lower supply growth coupled with positive demand leads to increasing prices, and salmon is no exception. In fact, in Europe salmon prices began reaching high levels already in mid-2013, but experienced two sharp seasonal (summer) corrections when Norwegian producers had strong supply in months of low demand (see Figure 4). In the United States (US), recent salmon prices have been relatively close to the five-year average since rising supply from Chile has been matching demand. If we consider the relatively low global supply expectations combined with strong global demand, prices in the coming two years are likely to be above average and in line with the high-cycle price level which started in early 2013, an opinion supported by futures prices (see Box 2).
Demand in the EU and especially the US should be good in the coming period

Demand for salmon is likely to remain strong. In the EU, the largest salmon consumer globally, there are no countries still in recession and the bloc is expected to return to modest but positive GDP growth. However, the EU is also the most mature salmon market, with leading markets such as France and the UK already having high salmon consumption per capita. High prices will counterbalance the improving economic conditions and limit salmon consumption growth.

Box 2: Prices expected to be high for two years at least, despite the ban on Norwegian salmon in Russia

Based on the forward curve in August 2014, the expectations are for a high price environment lasting well into 2016, despite the effects of Russia’s ban on Norwegian and EU salmon (see Figure 5). The expectation is that over 100,000 tonnes of Norwegian salmon will have to find a home somewhere else, most likely in the EU and to a lesser extent the US. Chilean and Faroe Islands salmon will supply the Russian market but it is unlikely they will be able to fully replace the Norwegian volumes. The effect of this reshuffling is a short-term price contraction and a downward shift of the futures curve. Nevertheless, although inducing volatility, the Russian ban does not change the overall high-cycle scenario even though prices are expected to come down somewhat after 2016 as global supply improves. However, the next 24 months will rarely see prices below those seen in the previous 24 months as they will be much higher than historical averages or cost of production which is approximately NOK 27/kilogramme.

In the US, the demand dynamics are different from those in the EU. While the macroeconomic environment is considerably better, salmon consumption per capita is relatively low, so there are still many potential new consumers. Despite the high prices, the US is expected to record gradually increasing Atlantic salmon consumption.

Japan is a large salmon market that rivals the US in total volume, but its preference for Pacific salmon (i.e. the red-fleshed salmon species) makes it somewhat exceptional. Pacific salmon is farmed in Chile or caught wild by fishing fleets. Due to a declining and ageing population, the Japanese market is contracting and has experienced a reduction of salmon consumption even in per capita terms. As the Japanese market has great diversity in the selection of high quality seafood on offer (particularly in the salmon price range), the high salmon prices will only accelerate the decline in consumption, especially that of the Pacific salmon species, where supply challenges are also present.
Developing economies are an even stronger driver of global salmon consumption

A new emerging driver in global salmon demand is the developing economies, especially China and Brazil. But there are also many other smaller markets, such as Turkey, Mexico, India, Indonesia, Malaysia, Taiwan, Singapore, South Korea and the Middle East, which as a group are becoming significant buyers of salmon. These markets are growing rapidly, driven by higher disposable incomes and the growing middle class as well as improving logistics. The salmon industry’s marketing efforts to position salmon as a premium, healthy and trendy protein are further improving market penetration in these regions.

In the last ten years, Russia has been a booming salmon market, but the political instability in Ukraine and the ban on salmon imports from Norway and the EU are likely to create a contraction of salmon consumption and even global price volatility. It is hard to estimate the impact of Russia’s import bans as many uncertainties remain. But as salmon consumption continues to globalise, there will be an increasing number of markets that can absorb any additional volume.

Ten years ago, all emerging markets combined consumed less than 20 percent of Atlantic salmon supply, but by 2014, their share reached close to 35 percent and is now twice the size of the US market. As consumption growth continues to globalise, we expect demand growth to be stronger in the next few years.

Processors and auxiliary industries challenged by the high-cycle environment

Over the next few years, the high-cycle conditions of high prices and low supply growth will be a challenge for the salmon processing industry. In Europe and North America, where the bulk of further processed salmon products, such as smoked salmon, are consumed, the processing industry has been a key driver of demand by creating new products, acquiring new consumers and communicating with the market. But squeezed between the volatility of the salmon spot prices and the large retailers—also engaged in price competition—the processing industry is in a difficult position. Consistent profitability among salmon processors has been a recurring issue and the coming few years are likely to be particularly challenging. Volatility rather than the absolute price level has been a major challenge for the processors. Some of the leading salmon farmers, such as Marine Harvest and Leroy Seafoods, have made acquisitions in salmon processing and become leading processors themselves. This trend is likely to continue and possibly accelerate in the coming few years as the salmon industry seeks further growth and control of the value chain.

A number of auxiliary industries that benefited from the expansion of the salmon industry, such as aqua feed and aquaculture equipment producers, will lose out in the coming period as their core market will expand slower than previously. The question of whether feed production and salmon farming provide synergies in a vertically integrated structure is regularly debated in the salmon industry, and some leading players have made structural changes in the past. For example, Nutreco, one of the leading aqua feed producers, divested its salmon farming operations (now Marine Harvest, the largest salmon farmer in the world), while Cermaq, the largest integrated farming and feed producer, divested its salmon feed unit EWOS to a private equity investor. Marine Harvest’s decision to build its own feed mills is a strategic move that aims to internalise the most important input into the salmon farming process while also providing another pillar for growth when organic growth in the core market slows down. The consequence of this new capacity for the aqua feed industry in a period of lower growth is that the prospect of expanding sales of salmon feed in the next two to three years will be further reduced and may even erode margins. This weak market growth rate is in stark contrast to the dynamics in the salmon feed industry in the period of 2011 to 2014, where the feed sector grew by nearly 50 percent, expanding in volume terms due to rapid growth of salmon farming and additionally in value terms due to rising cost of feed commodities.

Challenges can also be opportunities

The current situation may also present an opportunity for the supplier industries given the need for the salmon farming sector to solve the biological and sustainability challenges, especially for lice. Salmon farmers rely on the suppliers of equipment, medicines, genetics, vaccines or feed to introduce innovations that will help control lice and disease outbreaks, help achieve the ASC certification and ensure future growth of the industry. This is also a golden opportunity for established players and innovative start-ups to deploy unique technology, providing solutions such as eliminating lice or finding substitutes for fishmeal and fish oil.
Increased focus on sustainability, cost control and technological innovation

Sustainability on the agenda

Chilean producers are making a healthy turnaround after some five negative quarters, while European producers, primarily Norwegian farmers, are already enjoying a high level of profitability that is expected to be maintained for the next few years (see Figure 6). The key question is what farmers will do with this cash flow in an environment with relatively limited organic growth options. Rabobank expects that investing in biosecurity will receive the utmost priority and ample funding, especially when it comes to tackling the lice problems in Norway and Chile. Not only will reducing lice levels improve costs and environmental sustainability, but it is also a way to ensure that regulators allow further growth.

Although sustainability is not necessarily a function of tight supply, it will also be addressed within the framework of the sector’s commitment to the Aquaculture Stewardship Council (ASC) certification, as part of the Global Salmon Initiative (GSI) (see Box 3). By becoming ASC certified, the salmon industry will display sustainability credentials exceeding virtually any other modern aquaculture or livestock industry.

ASC certification will help the salmon industry achieve a key goal in changing the negative image it has acquired with some NGOs and certain customers. That could bring an end to the consumers conflicting views on the consumption of salmon on the one hand and the process of farming salmon on the other. While consumers perceive salmon as very healthy, there have been accusations of salmon farming of being unsustainable and harmful to the environment.

Although it can be argued that the environmental impact of salmon farming is no worse than that of other aquaculture sectors, and that, at the very least, it is better than the impact of livestock farming, salmon is a premium protein with a primarily affluent consumer base with high environmental awareness. If the GSI goals are achieved as planned by 2020, farmed salmon will not only be a leading protein in terms of its healthiness, but it will also be an example in terms of sustainability and the low environmental impact of the farming process. While not a direct consequence of the low supply growth scenario, in times of high prices and good profitability, it is much easier to undertake projects and afford the necessary expenses in order to improve sustainability, especially if these efforts go far beyond the requirements set by regulators, retailers or consumers.
**Box 3: Global Salmon Initiative (GSI)**

The GSI is a group comprising the majority of the world’s largest salmon farmers. Currently, the members account for more than 70 percent of the global Atlantic salmon production and aim to have all farms ASC certified by 2020. Although several modifications must be implemented before the industry can achieve ASC certification, the most challenging changes to make will be (1) reducing lice levels, (2) limiting the use of marine ingredients (especially fish oil) and finding sufficient quantities of sustainably certified marine ingredients and (3) managing the high frequency and costs of data collection. GSI members will cooperate by sharing knowledge and best practices to help each other achieve the ASC certification. This industry-driven commitment to what is considered a highly ambitious and challenging goal, but one with long-term benefits to both the industry and the environment, is unique not just in the aquaculture sector but also in the entire global animal protein industry. It is the first example of its kind where the members are truly committed to putting the environment before competition.

**Will salmon farmers consider options for diversification?**

It is clear that sustainability will be the primary goal going forward as the salmon industry works to establish itself as a leading example of sustainability in the aquaculture industry, and in the global protein industry. The salmon aquaculture industry offers a myriad of opportunities for growth even when supply volumes are no longer expanding as they have in the past. The next three years will allow the industry to explore these opportunities more than ever before. Some producers will choose to expand vertically in the value chain by focusing on value-added processing or feed (like Marine Harvest), while others may consider aquaculture of other species (e.g. fish, shellfish or perhaps even seaweeds).

Arguably lower organic growth could entice salmon farmers to opt for diversification of the business model. At the moment, very few salmon farmers have made significant investments in the aquaculture of other species. Aqua Chile’s investment in Tilapia (Oreochromis niloticus) in Costa Rica and Cooke Aquaculture’s investment in Sea Bass (Dicentrarchus labrax) and Sea Bream (Sparus aurata) production in Spain are examples, but there are few others. Simply put, so far the sentiment of most salmon farmers is that being good at salmon farming does not mean you can also be good at farming other species. If diversification into other species occurs, it will be based primarily on financial diversification rather than operational synergies.

A potentially more synergetic opportunity could be the aquaculture of algae and seaweeds, a sector that is receiving increasing attention from academia, investors and the salmon industry. Numerous algae and seaweed species can be farmed for a diverse range of markets and purposes including human consumption, the production of feed proteins and oils, as well as ingredients for the pharmaceuticals industry. In some cases, seaweed can be grown symbiotically adjacent to the salmon cages, absorbing the nutrients from the fish excretions while oxygenating the water necessary to the salmon. As an added benefit, preliminary trials have shown that seaweed fields provide shelter for various small fish and invertebrates, some of which, such as the lumpfish (Cyclopteridae family), prey on the sea lice infesting the salmon pens. It is much too early to call this a major opportunity for the sector, but it is an example of the potential of salmon aquaculture to find growth solutions which are both profitable and good for the environment.

**A focus on cost control**

In the coming years, the salmon industry will likely have an increased focus on cost control. The cost of salmon farming has increased significantly over the last few years, driven by feed costs, biological performance costs (i.e. related to lice and mortality) and non-feed costs. This last element includes a long list of administrative and legal changes that have added to the expenses incurred by farmers. The most obvious element to focus on will be improving biological performance. Certainly in Chile, we are seeing a major turnaround with a strong momentum likely to continue well into 2015. And, while outside of the control of the farming industry, feed cost per tonne—driven by a record soybean harvest expected in 2015—should stabilise after a few years of growth.
Looking for ways to expand supply

In some regions, such as Russia, Ireland and Iceland, salmon farming is expanding rapidly. But even if this expansion continues, which is by no means guaranteed, it is from such a low base that even by 2020 it will be hard to see a material impact from these regions on global production. Some growth can also be achieved in Scotland, the third-largest salmon farming region. The Scottish industry aims to increase its current production of 150 thousand tonnes to above 200 thousand tonnes by 2020. While significant for Scotland, this represents only 2.5 percent additional supply to the global market.

In Chile, as mentioned above, Region XII is where the industry can still grow. However, lack of infrastructure and high costs due to the great distance to processing and export facilities are challenges that will slow expansion in this area. Sensitive regions with high biodiversity will also need to be respected. Establishing marine parks could potentially further limit growth in Region XII. In terms of timing, it is likely that part of the near-term growth in Region XII will come from redistributing production from the other two regions, where production density has potentially surpassed the optimal point. A rough estimate is that eventually 20 percent to 30 percent of the Chilean supply could originate in Region XII, but this is likely to take five to ten years.

Norway produces over 50 percent of the world’s Atlantic salmon, and we do not expect this to change in the foreseeable future. The new licences combined with the extension of the MAB, provided lice numbers are low, and larger smolt, will enable further growth. It will not be as much as in previous years, but will still be significant. In the longer term, in the absence of other changes, larger smolt can continue to drive growth (see Box 4).

Box 4: Larger smolt and land-based production as options for incremental supply growth

Increasing the smolt size is a way to essentially move part of the marine stage of the production cycle inland. The length of time salmon are in the fresh water land-based facility increases, while the time the salmon are in the sea decreases, effectively allowing the sea-based licences to be used more efficiently. An additional benefit is that large smolt could be better at dealing with the stress of the transfer to the marine stage, which can limit mortality and boost the growth rate. But this comes at a cost as land-based production has a far higher cost then sea-based production since the entire living environment needs to be recreated artificially. The water needs to be recirculated and processed to remove impurities while insuring oxygenation and correct temperature and light. Moreover, the fixed cost of building this type of facility is also substantially higher than setting up the floating pen cages along the coast. Nevertheless, some producers are already constructing facilities which will allow them to increase the size of the smolt. In the next few years, these producers are likely to generate growth exceeding the rest of the industry. It is reasonable to expect that if prices remain high and no new options are found to increase supply, then more and more producers in Norway will adopt this strategy. However, this too would require a number of years before having a significant effect on supply.

Although it is very difficult to make a viable business case for fully land-based farmed salmon at the moment, this could change if prices remain high for a long period of time due to capacity constraints, especially if disease and parasite issues worsen. The land-based recalculation farming technology is evolving rapidly, and while it may still be far too costly and possibly unreliable it does have some advantages. With no link to the external marine environment, at least in theory, there should be no risk of impact from disease or parasites such as lice, nor should any surprises follow as a result of changing weather conditions. The salmon farms are also unlikely to have much impact on the marine environment. A worsening of marine conditions (disease, parasite, climate change or pollution) and an improvement of the land-based technology could improve its business case, but given the vast capital needed to achieve this, it will take years of high salmon prices before there is a material effect on global supply.

In other protein sectors, such as poultry or pork, the switch to closed containment occurred in the last 30 years, primarily with the goal to limit disease risks and weather effects, albeit potentially to the detriment of animal welfare. But salmon is not a land-based animal and it can be argued that closed containment makes more sense if placed in the sea. Arguably, the next big innovation in the salmon industry could be closed or at least less open systems than the currently used floating collar and net system where there is no barrier between the salmon and the marine environment. Especially in Norway, there are a number of ongoing projects for this type of technology, and we may see successful commercial scale systems implemented in the medium term. Alternatively, many small changes to the current cage design may eventually lead to a similar result. In this way, the best of both worlds would be utilised, with both the low cost of processing the water (impurities, oxygenation, temperature), and a reduction in the negative impact from and to the marine environment (such as lice and diseases).
Lastly, and controversially, long-term supply growth could also be boosted with genetic modification (GM) technology. Although GM salmon is not allowed in the EU or the US, it is theoretically possible that it could be sold to some of the emerging markets. The currently available GM technology promises to reduce the production time of salmon and the need for marine proteins and oils in the feed. In the future, GM salmon could also have improved resistance to lice and disease. With developing markets gaining significance, it is possible that some producers will consider GM salmon, although at the moment no large-scale salmon producer is using this technology. Perhaps GM salmon may prove to be a step too far, but GM ingredients such as GM soymeal and oil are already used in animal proteins. Using these ingredients, at least for salmon destined for countries that accept this type of product, such as Brazil and China, could be a way to reduce costs.

Innovation in this dynamic industry will prevail and ensure growth. Even with the low growth forecast for the next three years and keeping expectations fairly conservative beyond this period, the Atlantic salmon industry should be able to reach 3 million tonnes by 2020, which is 1 million tonnes more than the 2013 production (see Figure 7).

![Figure 7: Long-term growth potential of Atlantic Salmon aquaculture, 2005-2020](image.png)

Source: Rabobank, based on Kontali historical figures, 2014

Eventually, salmon farming will need to expand to open waters. Intermediary steps may need to be taken in which the industry first develops farming on more exposed sites that are still close to the shore. The barriers for this development are legal rather than technological. Ultimately, rugged enclosures able to withstand the conditions of the open ocean will need to be developed. This may prove challenging, but a number of viable technologies are already in development. If successful, in addition to Norway and Chile, many other countries where water temperature is suited for salmon farming, could develop offshore farming, including Russia, Canada, the US, New Zealand and Australia, as ultimately, protected coast lines would no longer be a constraint to the industry. However, offshore farming is probably at least a decade away.

**Growth will return—the question is when, where and how**

As the saying goes, the solution to high prices is high prices. The salmon industry is still a young sector with one of the best demand functions of any protein. Thanks to high prices, investments in the sector will accelerate and solutions to the current bottlenecks will be found. Growth will undoubtedly return; but when, where and how remain unknowns.

In two or three years’ time, possibly due to technological innovation, the salmon farming industry is likely to solve many of the biological and environmental issues that are currently being tackled. This should give regulators and producers confidence in both the industry and the technology. This could be followed by new or larger production licences, no doubt with increasingly more stringent environmental conditions. Alternatively, with larger smolt, closed containment farming, land-based farming or a technology not yet known, supply will eventually match global demand as this is a young and innovative industry, leading the blue revolution.