Cost and Market Realities in Open Water Aquaculture

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Introduction

With a title which talks about costs and market realities it might seem that this could be a somewhat pessimistic look at the future for open water aquaculture, but this is not intended to be the case. It is emphasized in the outset that this author is a believer in open water aquaculture and that the cautious and reality checks discussed merely reinforce my view that this is where a major part of our industry's future lies.

This paper will discuss costs and prices and the value expectations of mass markets and what aquaculture, be it inshore or offshore, has to offer if it is ever going to deliver on its promise of providing a major new source of seafood. In doing this it will draw heavily on experience from salmon farming because this is an industry which, for twenty-five years now, has been going through a dynamic and sometimes painful evolution as it contends with cost and market realities.

As we contemplate new aquaculture technologies and the farming of new species we would be foolish not to learn from this test of experience.

The cost of Water

It's a statement of the obvious, but aquaculture is all about growing things in water. So it follows that, if we want to grow a lot of things, we need a lot of water. Yet a great deal of modern aquaculture seems to want to deny this obviousness and tries to grow a lot of things in a little water. The title of this paper could just as easily have been "Cost and Market Realities in Closed System Aquaculture" where, it is suggested, ex-
It is also true that over the past 30 years, the salmon farming industry has grown from almost nothing to over 500,000 metric tons, while, in the same time, production of fish in intensively managed, closed systems remains at probably less than five percent of that. Or, why is it that, despite numerous attempts to grow salmon in land-based, pump-in-place systems, almost all of them have failed, so that now it is doubtful that more than a thousand tonnes or so, out of the total of 500,000, is grown in this way?

The answer is that cage farming is an energy efficient, mechanically simple, easily replicated and, above all, cost-efficient method of managing water in aquaculture and, when located correctly, provides a level of water exchange past the fish that those opening land-based tank systems can only dream about. Some may dispute the idea that the water is free. There are obviously costs associated with permits, leases, environmental monitoring, etc. But, compared to land-based tanks, cage farms are able to provide growing space and water exchange through an amount of the cost required to support land-based installations. Compared to other approaches in aquaculture, this is the single most important reason why open ocean systems have such an enormous potential. It will allow access to lots of water.

It should be made clear here that these comments relative to what might be called the “westernized aquaculture” of mostly carnivorous, high-quality species of fish, which are demanded by consumers in the world’s developed economies. It can quite rightly be pointed out that a Chinese carp pond, effectively a solar powered, closed system, and these ponds not only produce most of the world’s cultured fish at present, but they do so at costs which, if their product was appreciated by western consumers, would put growers of salmon, trout, and other fish out of business. It is important to keep in mind that while the opportunities for open water marine aquaculture are enormous, in volume terms, production of fish in tanks, mostly freshwater water ponds, dominates global aquaculture production today and is likely to continue to do so for years to come.

Market Realities

Much of the justification for increased interest in marine aquaculture, indeed for this conference, is based on forecasts of a future global seafood deficit of millions of tonnes per year, caused by increased consumer demand and resource problems in the world’s natural marine fisheries. It is a situation which provides a compelling logic for aquaculture and has attracted the attention of politicians, and even the investment community, in a way which it has been hard to do up to now.

Overlooked in this logic, though, is that the millions of tons of projected seafood deficit is predominantly for fish which sell at much lower prices than most people contemplating aquaculture ventures can live with. Just because fish supplies may be short in future, it does not mean that most people will therefore pay any price to maintain their level of consumption. They won't, they'll eat chicken or less-cost processed meats, or just reduce their consumption of animal protein generally, which is arguably too high anyway. There is no law that says people have to eat a certain amount of seafood. They will, as they do now, keep on eating, if future aquaculture offerings do not provide competitive value, they will not sell.

The salmon industry provides an excellent example of what happens when an aquaculture product moves from a niche, or luxury status to a mainstream food item. It’s one of the great achievements of salmon aquaculture, incidentally, that it has been able to make this transition. Only seven years ago, when not much more than 150,000 tons of salmon was farmed world
wide, the wholesale price for fresh head-on girted Atlantic was over $1.00 per pound. Today, with small-scale production at about 300,000 tons, it is less than half of this at between $0.80 - $2.25 per pound. But the projected global seafood deficit we are seeking to do something about are for millions of tons, so where 300,000 tons may sound like a lot it is, in reality, a relatively modest contribution to the overall world seafood supply, or indeed to the food supply generally. Compare it for example with over 12 million tons of chickens that the U.S. alone produces and consumes each year.

The point is that mass markets are huge and provide huge opportunities, but they demand volume and that means reasonable prices. High, high price markets on the other hand are small, have minimal impact on overall seafood consumption and they are highly vulnerable to over-supply.

So, if the vision of those who would develop open water aquaculture is to contribute meaningfully to the nation's seafood supply, they will have to do so in a way which allows them to compete at the mass market environment and that can only happen if fish are produced at a cost which allows for wholesale prices no higher than we are now paying for salmon and preferably lower still. It's true that some new species will command higher prices in the early stages of their development, but not for long. Ask producers of hybrid striped bass, or sturgeon, how they have seen their prices fall in response to only modest increases in volume.

Yield

A critical factor in providing competitive value and one which is often overlooked, is choosing new species for aquaculture is high yield. Most people do not want to pay for fish, they want to use their money to buy food. A key component of value in any market is when the amount of edible meat there is in a pound of whatever it is they buy. Different species of fish have markedly different flesh yields. Tuna for example is a low yielding fish at about 32 percent, compared to Atlantic salmon, which is one of the highest yielding of all fish at up to 60 percent. Several other aquaculture species like catfish and hybrid striped bass yields something in between, in the range of 40 - 45 percent.

These different yields have a major impact on the economics of production. As an example, for a fish with a 40 percent yield to compete with a fish yielding 60 percent it has to be grown on a pound weight basis, for two-thirds of the cost. That's a huge difference when you consider that the cost to feed most of them is likely to be about the same and makes up about 50 percent of all growing costs. That means then for the 40 percent yielding fish, if it's going to be competitive, all the other costs, like personnel, labor, insurance and general operation, have to be no more than a third of those for the fish yielding 60 percent and in most cases that will never be possible.

Fish like tilapia and catfish are competitive because, as consumers, the cost to feed them is significantly less. I am not aware though of any oyster species that are being considered for open water farming, especially in temperate latitudes. The high quality species that we would like to grow are all well adapted to the food chain, and there are likely to cost about the same. That being so and if we are seeking to select fish for open water aquaculture which have mass market potential, it is essential that they have a high yield.

This is what is meant by "market realities," perhaps a better term would have been "mass market realities," They provide an obvious challenge and a clear goal. If offshore aquaculture is ever going to be anything more than a boutique industry providing small quantities of expensive seafood to niche markets, its costs must be competitive. There is no point in designing structures and breeding systems, no matter how clever they may be, which do not provide the possibility of low-cost production and there is no point in se-
There is no reason why costs of feed and supplies should be higher for an offshore facility compared to a conventional inshore farm and the case can be made that they could be less, because better water conditions and water flow in an offshore environment will lead to better health, growth, and survival. Nor should there be a penalty for labor costs. A well-designed and well-equipped offshore farm should, at least, be capable of producing 100 metric tonnes per year, which is an average today for many inshore farms, and it is quite likely that productivity could be much higher than this, if operations are fully mechanized. Fish mortality insurance for offshore farms, which is a big item in most inshore salmon farm budgets, should also be reasonable once cage designs are proven, and it can be argued that because some risks, like phytoplankton blooms, will probably be less, premiums may even be lower. And the same applies to costs of administration and the financial cost of working capital. All of these costs should be roughly the same, irrespective of where the fish are grown.

Where there are likely to be cost penalties in farming offshore is in the areas of operations support and the financial costs of fixed capital, i.e., interest, depreciation, and expected return to investment. But this is where using established costs from the inshore industry as benchmarks can be helpful in imposing reality. Any additional costs incurred in these areas will have to be made up somewhere else. There are some opportunities for doing this which will be discussed later. But, in general, offshore farms are going to have to be able to operate without too much of a penalty in these areas, or they will not be competitive.

It should be noted that supporting, supplying, and maintaining a fish farm in an offshore environment is likely to be more difficult and therefore more expensive than doing the same thing inshore. Bigger and better-equipped boats, additional safety procedures, downtime due to bad weather, will all add to more cost. A goal might be to say that they should be no more than double what it would cost inshore, or

### Table 1: Salmon Farming Costs

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>$5 per pound, en farm</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Administrative/Total</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Profit (Can costs)</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Working capital</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>Total unaffected costs</td>
<td>1.32</td>
<td>85.7</td>
</tr>
<tr>
<td>Affected costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations support</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Fixed capital</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Total affected costs</td>
<td>0.32</td>
<td>13.3</td>
</tr>
<tr>
<td>Total Costs</td>
<td>1.64</td>
<td></td>
</tr>
</tbody>
</table>
It can be argued with some justification that in an offshore environment, better water quality and higher densities of water exchange will allow higher working densities and therefore more production per cubic meter. But this is a trade off to be treated very cautiously. It would be much better to de-risk the business which costs less to de-risk with and to treat any benefits from higher densities as extra contingency rather than to impose the need for higher densities as a condition of financial viability.

As a capital cost goal it is suggested that anything above a cage cost of $30 per cubic meter is going to make it very difficult to justify investment in an offshore fish farm. Compared to an onshore farm equipped with large, plastic circular fish results in a cost penalty of $6.24 per pound, which is 15 percent of the total generalized costs in Table 1 and is more than enough of a burden for any farm to carry. In fact unless some of it can be recovered somehow it is probably too much. There are not too many businesses that can survive in a commodity market with a cost penalty this large.

**Non-Farming Costs**

So, the question is, can these higher costs be made up somewhere else? It is suggested that they can in the area of what will be called “non-farming costs”. i.e. all those costs associated with harvesting, processing, packaging, and distributing the fish for sale to consumers. Up to now the main focus of this paper, and of salmon farming generally, has been on how to reduce the cost of farming and, as most of you probably know, there have been many efforts in farm efficiency to recent years. There has been much less attention given to the “non-farming” costs. These can quickly add up to large numbers and, as the cost of growing salmon complexes, these non-farming costs are now assuming and ever increasing proportion of the final cost or price, consumers have to pay.

In terrestrial animal production this is called the “price spread” and is calculated each month for beef.
pack and checked by the USDA. It measures the overall costs of getting different meat products from farm to market, or in this case, from the farm to the processor. This is a value added to any other value found on the original farm and reflects the marketing system's effect on the final price of the meat. Table 3 shows some values taken from a 1996 report on cost kernels in farmed salmon produced by the State of Alaska Department of Commerce, updated to reflect current pricing in the farmed salmon market.

Table 3: Price Equivalents for Different Meat Products Produced from Atlantic Salmon (All in U.S. per Pound)

<table>
<thead>
<tr>
<th>Product</th>
<th>Bass</th>
<th>Rock</th>
<th>Chicken</th>
<th>Atlantic</th>
<th>Mackerel</th>
<th>Salmon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm gate price (in $)</td>
<td>1.62</td>
<td>0.68</td>
<td>0.43</td>
<td>0.28</td>
<td>0.18</td>
<td>0.65</td>
</tr>
<tr>
<td>Slaughter and freezing</td>
<td></td>
<td>0.18</td>
<td>0.14</td>
<td>0.23</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Boning and mincing</td>
<td>0.63</td>
<td>0.02</td>
<td>0.44</td>
<td>0.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slicing and packaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.23</td>
</tr>
<tr>
<td>Canning &amp; marinating</td>
<td>0.16</td>
<td>0.85</td>
<td>0.58</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail price</td>
<td>2.94</td>
<td>1.93</td>
<td>0.87</td>
<td>0.84</td>
<td>0.80</td>
<td></td>
</tr>
</tbody>
</table>

*All Atlantic salmon costs are adjusted for 16% edible yield from gilled weight.

The first point to emphasize is that the salmon prices chosen are not those for whole, head-on fillets, which are the most valuable. These prices are calculated at a distribution rate of 10% per pound, which is the average of the best and worst distribution rates observed in the market, and the final retail price is calculated to reflect the current retail price of all the products listed.

The second point to emphasize is that the assumptions used in this analysis are not necessarily accurate because the costs include all factors, and in some cases, even factors that are not related to the cost of producing a product. However, these assumptions allow for a reasonable comparison of the cost of producing each product and are therefore a fair basis for comparison.

Table 3 includes additional information on the cost of producing each product, including the cost of processing, packaging, and transportation. This information can be used to estimate the cost of producing each product, and by comparing the cost of producing each product, it is possible to determine the relative cost of producing each product.

The third point to emphasize is that the cost of producing each product is not only affected by the cost of producing the product itself but also by the cost of producing the ingredients used in the production of the product. This is because the cost of producing the ingredients can be a significant portion of the overall cost of producing a product.

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Compare this situation to today's salmon farms, which in the north of Norway, south of Chile or northern B.C., can be hundreds of miles from the nearest food plant or hatchery. If there is a local processing plant it is usually small and does not work five full shifts a week, let alone multiple shifts every six or seven days. Transport of eggs and feed requires trucks, boats and even helicopters to get them where they are needed and maintain the fish, when they are finally processed and ready for sale, are usually thousands of miles away. It would probably be an exaggeration to say that in some cases the cumulative cost of transportation from farm to final consumer is now more than it costs to grow the fish on the farm in the first place.

Open ocean farming provides a way to deal directly with these problems. When the technology is ready, it will be possible to develop clustered farming operations with many thousands of tons of production, all within a reasonable distance from shore and much closer than most farms are now to major markets. The farms could be operated from shore bases with fully mechanized life-for-life handling, a feed mill, and a processing plant, and in places like Maine, New Brunswick or the State of Washington, they could be developed alongside and as part of the existing industry, thereby providing wait-staging opportunities for all.

This may all seem a bit futuristic and perhaps we look at aquaculture today, but the point is there are solid cost-saving reasons for doing so and therefore the incentive for large scale investment by those who recognize the opportunity. There is the potential to cover all the costs discussed earlier and more, especially when it is figured that the cost of fuel and transport are likely to increase faster than some other costs in the years ahead, so putting them in distant corners of the globe at an even greater disadvantage.

If it is agreed that our long term goal is, or should be, to make a dent in those well publicized, global foodstuff deficits and to provide healthful, wholesome food for mass-markets consumption, then it means growing millions of tons, not hundreds of thousands, as the salmon farming industry does today. It also means processing and distributing them at a cost which makes them affordable. It is hard to see how this will be done by an industry that has to reach farther and farther into remote and inaccessible parts of the world in order to find places to do it. It seems much more likely to be done by an industry that learns how to farm in its own very large and accessible back yard.