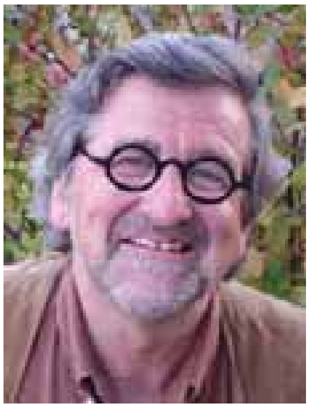
Session 1: Aquaculture growing strength

Jochen Nierentz



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Jochen Nierentz has more than 25 years experience in marketing and international trade of fishery products. Working for the FAO Fisheries and Aquaculture Department since 1978, he has covered particularly Latin America and Asia where he was stationed in regional projects. He created the GLOBEFISH services based in FAO headquarters (HQ) in Rome, Italy and cooperated closely with the fisheries administrations in Europe and North America, many of which joined GLOBEFISH as member institutions. In 1996, he set up the EASTFISH project in Copenhagen covering 19 Central and Eastern European Countries that became the EUROFISH International Organisation in 2001. He holds a Master in Agriculture and a Master in Economics from the universities of Munich and Goettingen. Presently he is Senior Officer, Marketing, in charge of the GLOBEFISH unit in the Fisheries Utilization and Marketing Service (FIIU) in FAO HQ. In this function he is also responsible for backstopping the activities of the FISH INFONetwork (FIN), formed by the independent intergovernmental organizations INFOPESCA (Latin America), INFOFISH (Asia Pacific), INFOPECHE (Africa), INFOSAMAK (Arab Countries), INFOYU (China) and EUROFISH.

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Overview of production and trade – the role of aquaculture fish supply

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ABSTRACT

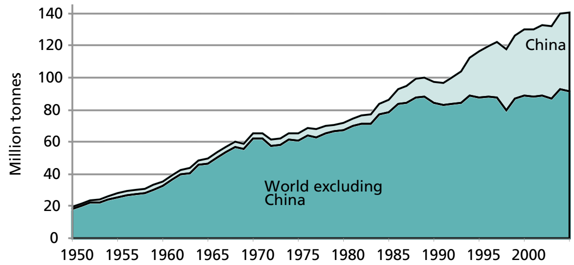
Capture fisheries and aquaculture supplied the world with about 108 million tonnes of foodfish in 2005, with aquaculture accounting for 45 percent of the total. Apparent per capita supply reached 16.7 kg (live weight equivalent), the highest on record. Growth in supply from aquaculture more than offset the effects of stable capture fishery production levels and a growing population. Aquaculture continues to grow more rapidly than all other animal food-producing sectors. Worldwide, the sector has grown at an average rate of 8.8 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems over the same period. In terms of foodfish supply (excluding 13.4 million tonnes of aquatic plants) the world's aquaculture sector produced about 15 million tonnes of farmed aquatic products in 2004 (excluding China). Corresponding figures reported for China are about 31 million tonnes from aquaculture and 6 million tonnes from capture fisheries, a powerful indication of the dominance of aquaculture in China. The growth in production of the different major species groups continues, although the increases seen so far this decade are less than those realized during the extraordinary growth in the 1980s and 1990s. Over 240 different farmed aquatic animal and plant species were reported in 2004.

INTRODUCTION

Capture fisheries and aquaculture supplied the world with about 108 million tonnes of foodfish in 2005, providing an apparent per capita supply of 16.7 kg (live weight equivalent), which is the highest on record (Figures 1 and 2, Table 1).[1] Of this total, aquaculture accounted for nearly 45 percent.

Estimates for 2005 indicate that total world fishery production for human consumption represented an increase of over 2 million tonnes compared with 2004 and a record

FIGURE 1
World capture and aquaculture production



[1] Fishery production data given in the tables and figures presented in this paper exclude the production for marine mammals, crocodiles, corals, sponges, shells and aquatic plants.

FIGURE 2
World fish utilization and supply, excluding China

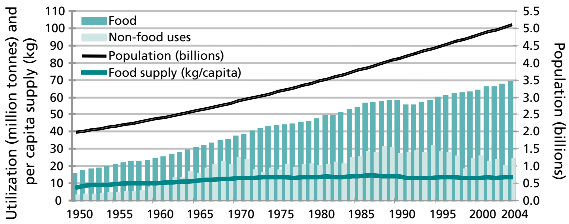
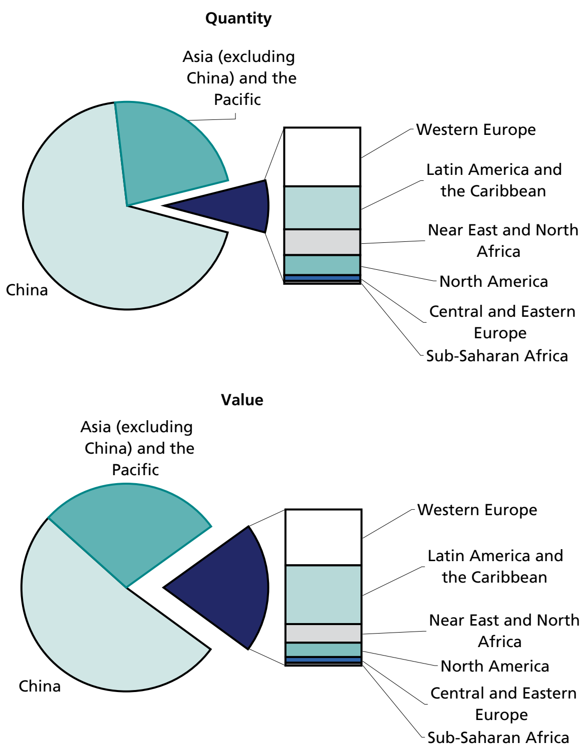


FIGURE 3
Aquaculture production by regional groupings in 2005



high production. There was a decrease in the contribution of capture fisheries, but this was offset by an increase in the aquaculture contribution.

China remains by far the largest producer, with reported production of fish, crustaceans and molluscs of 48.7 million tonnes in 2005 (16.7 and 32.0 million tonnes from capture fisheries and aquaculture, respectively), providing an estimated domestic food supply of 29.1 kg per capita (2005 data), as well as production for export and non-food purposes (Figure 3). Because of the importance of China and the uncertainty about its production statistics, the country is analyzed separately from the rest of the world under the framework of FAO's State of World Fisheries and Aquaculture (SOFIA).[2]

Aquaculture continues to grow more rapidly than all other animal food-producing sectors, with an average annual growth rate for the world of 8.7 percent per year between 1970 and 2005, compared with only 1.1 percent for capture fisheries and 2.9 percent for terrestrial farmed meat production systems. However, there are signs that the rate of growth for global aquaculture may have peaked, although high growth rates may continue for some regions and species. Aquaculture production of fish, crustaceans, molluscs and other aquatic animals in 2005 was reported to be 48.1 million tonnes (Table 1) with a value of US$ 70.9 billion or, if aquatic plants are included, 62.9 million tonnes with a value of US$ 78.0 billion. Of the world total, China is reported to account for nearly 70 percent of the volume and over half of global value of aquaculture production. All regions showed increases in production from 2002 to 2005, led by the Near East and North Africa region and Latin America.

AQUACULTURE PRODUCTION

The contribution of aquaculture to global supplies of fish, crustaceans, molluscs and other aquatic animals[3] continues to grow, increasing from 3.9 percent of total production by weight in 1970 to 27.1 percent in 2000 and to 34.0 percent in 2005. Aquaculture continues to grow more rapidly than all other animal food-producing sectors. Worldwide, the sector has grown at an average rate of 8.7 percent per year since 1970, compared with only 1.1 percent for capture fisheries and 2.9 percent for terrestrial farmed meat production systems over the same period (1970–2005). Production from aquaculture has greatly outpaced population growth[4], with per capita

[2] Available at http://www.fao.org/docrep/009/A0699e/A0699e00.htm.
[3] Also includes amphibians (frogs and turtles).
[4] Population has increased with an average annual growth rate of 1.6 percent during the same period.

TABLE 1
World fisheries and aquaculture production and utilization (million tonnes)

	2000	2001	2002	2003	2004	2005
Inland:						
Capture	8.8	8.8	8.7	8.9	8.9	9.5
Aquaculture	21.3	22.6	24.0	25.5	27.8	29.3
Total inland	*30.1*	*31.4*	*32.7*	*34.4*	*36.7*	*38.8*
Marine:						
Capture	86.8	84.2	84.5	81.4	85.5	83.7
Aquaculture	14.2	15.4	16.4	17.2	18.2	18.8
Total marine	*101.0*	*99.6*	*100.9*	*98.6*	*103.6*	*102.6*
Total capture	*95.6*	*93.0*	*93.2*	*90.4*	*94.4*	*93.3*
Total aquaculture	*35.5*	*38.0*	*40.4*	*42.7*	*45.9*	*48.1*
Total fishery production	**131.1**	**131.0**	**133.6**	**133.0**	**140.3**	**141.4**
UTILIZATION						
Human consumption	97.0	100.2	100.5	103.3	105.6	108.0
Non-food uses	34.0	30.8	33.1	29.7	34.7	33.4
Population (billions)	6.1	6.1	6.2	6.3	6.4	6.5
Per capita food fish supply (kg)	16.0	16.3	16.1	16.4	16.6	16.7

TABLE 2
World fisheries and aquaculture production and utilization, excluding China (million tonnes)

	2000	2001	2002	2003	2004	2005
Inland:						
Capture	6.6	6.7	6.4	6.5	6.5	7.0
Aquaculture	6.1	6.6	7.1	7.8	8.9	9.2
Total inland	*12.7*	*13.3*	*13.5*	*14.2*	*15.3*	*16.2*
Marine:						
Capture	72.0	69.9	70.2	67.1	71.0	69.2
Aquaculture	4.8	5.3	5.5	6.0	6.5	6.5
Total marine	*76.8*	*75.2*	*75.7*	*73.2*	*77.5*	*75.8*
Total capture	*78.6*	*76.5*	*76.6*	*73.6*	*77.5*	*76.2*
Total aquaculture	*10.9*	*11.9*	*12.6*	*13.8*	*15.3*	*15.8*
Total fishery production	**89.5**	**88.4**	**89.3**	**87.4**	**92.8**	**92.0**
UTILIZATION						
Human consumption	63.8	66.0	65.8	67.8	68.8	69.8
Non-food uses	25.7	22.4	23.5	19.6	24.0	22.2
Population (billions)	4.8	4.9	5.0	5.0	5.1	5.1
Per capita food fish supply (kg)	13.2	13.5	13.3	13.5	13.5	13.6

supply from aquaculture increasing from 0.7 kg in 1970 to 7.4 kg in 2005, an average annual growth rate of 7.0 percent.

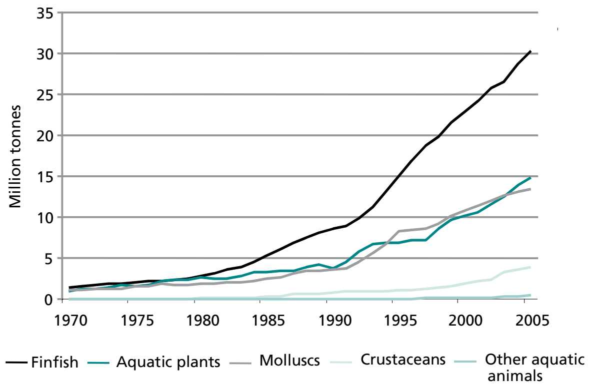
World aquaculture (foodfish, crustaceans, molluscs and aquatic plants) has grown significantly during the last half-century. From a production of below one million tonnes in the early 1950s, production in 2005 was reported to have risen to 62.5 million tonnes, with a value of US$ 76.6 billion. This represents an average annual increase of 6.5 percent in volume and 8.1 percent in value, respectively, over reported figures for 2002. In 2005, countries in the Asia-Pacific region accounted for 91.8 percent of the production volume and 79.6 percent of the value. Of the world total, China is reported to produce 69.1 percent of the total volume and 51.4 percent of the total value of aquaculture production (Figure 3).[5]

[5] The regions match those presented in the analysis of "The State of World Aquaculture" presented to the COFI Sub-Committee on Aquaculture, New Delhi, September, 2006. (FAO Fisheries Technical Paper No. 500).

TABLE 3
Top ten aquaculture producers of foodfish supply: quantity and emerging growth, 2002–2005

Producer	2002	2005	APR
Top ten producers in terms of quantity			
	Tonnes		Percentage
China	27 650 815	32 008 686	5.0
India	2 187 189	2 837 751	9.4
Viet Nam	703 041	1 437 300	27.0
Indonesia	914 046	1 197 013	9.5
Thailand	950 718	1 140 057	6.9
Bangladesh	786 604	882 091	4.0
Japan	817 361	737 429	-3.3
Chile	545 655	698 214	8.8
Norway	551 297	656 636	6.0
Philippines	443 537	557 251	8.0
Other	4 681 681	5 559 019	6.0
Top ten producers in terms of growth			
Producer	**2002**	**2005**	**APR**
	Tonnes		Percentage
Myanmar	190 120	474 510	36.6
Viet Nam	703 041	1 437 300	27.0
Turkey	61 165	119 177	25.0
Mexico	73 599	117 420	16.9
Republic of Korea	274 625	420 296	16.2
Iran (Islamic Rep. of)	76 817	117 354	15.2
Egypt	376 296	539 748	12.9
Indonesia	914 046	1 197 013	9.5
India	2 187 189	2 837 751	9.4
Chile	545 655	698 214	8.8

FIGURE 4
Trend of world aquaculture production by major species groups, 1970–2005



In terms of foodfish supply, the aquaculture sector in the world excluding China produced 15.8 million tonnes of farmed aquatic products in 2005 (Table 2), compared with about 54 million tonnes from capture fisheries destined for direct human consumption. Corresponding figures reported for China are about 32 million tonnes from aquaculture and about 6 million tonnes from capture fisheries, a powerful indication of the dominance of aquaculture in China.

The growth in production of the different major species groups continues (Figure 4), although the increases seen so far this decade are less than those realized during the extraordinary growth in the 1980s and 1990s. The period 2000–2005 has seen strong growth in production of crustaceans, in particular, and in marine fish. Growth rates for the production of the other species groups have begun to slow, and the overall rate of growth, while still substantial, is not comparable with the increases seen in the previous two decades. Thus, while the trend appears to be continued increases in production in the near future, the rate of these increases may be moderating. Table 4 and Figure 5 present an overview of aquaculture production in terms of quantity and value by major species group for 2005.

The top ten species groups in terms of production quantity and in terms of percentage increase in the production quantity from 2002 to 2005 are shown in Table 5. Production of carps far exceeds all other species groups, accounting for over 40 percent (19.5 million tonnes) of total production of fish, crustaceans and molluscs in 2005. Combined, the top ten species groups account for 91 percent of the total aquaculture contribution to fisheries food supply.

The increasing diversity of aquaculture production can be seen in the list of species groups registering the largest growth from

TABLE 4
World aquaculture production: average annual rate of growth for different species groups (percentage increase)

Time period	Crustaceans	Marine Fishes	Freshwater fishes	Molluscs	Diadromous fishes	Overall
1970–2005	19.2	10.8	9.3	7.7	7.2	8.8
1970–1980	24.6	13.7	6.8	5.8	7.6	6.8
1980–1990	24.6	6.0	12.2	6.9	9.2	10.3
1990–2000	10.1	12.2	10.2	11.3	7.1	10.2
2000–2005	17.5	10.5	6.4	5.1	5.3	6.6

2002 to 2005 (Table 6). Sea urchins and other echinoderms lead the list with a remarkable increase in reported production from 25 tonnes in 2002 to 71 899 tonnes in 2005. In reality, while this does represent an area of emerging activity in aquaculture, this item also reflects an effort made by China to improve its reporting of aquaculture data. Beginning in 2003, China greatly expanded the number of species reported in their aquaculture data, including 15 new freshwater species and 13 new marine species.

Most aquaculture production of fish, crustaceans and molluscs continues to come from the freshwater environment (57.4 percent by quantity and 45.0 percent by value). Mariculture contributes 34.7 percent of production quantity and 40.5 percent of the total value.

Unlike terrestrial farming systems where the bulk of global production is based on a limited number of animal and plant species, over 240 different farmed aquatic animal and plant species were reported in SOFIA 2004, an increase of 20 species compared to the number reported in SOFIA 2002.

It is noteworthy that the growth of aquaculture production of fish, crustaceans

FIGURE 5
World aquaculture production: major species groups by quantity and value in 2005

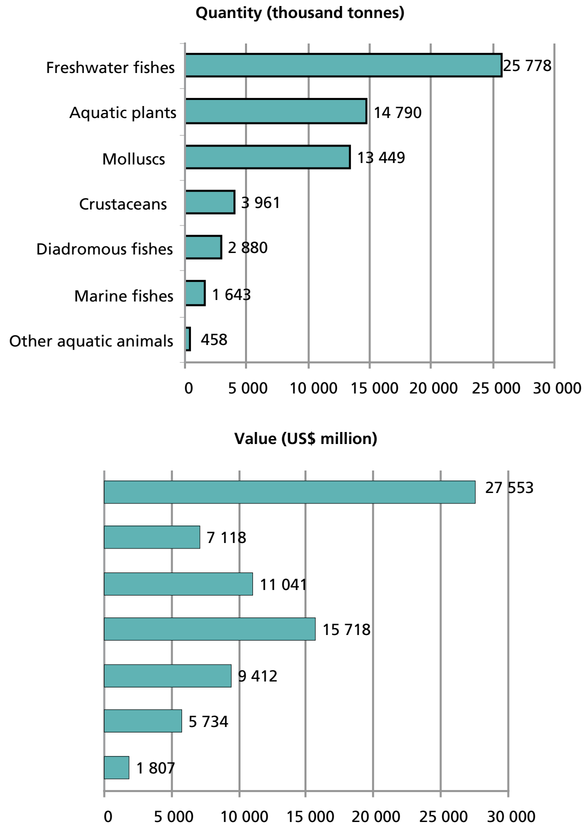


TABLE 5
Top ten species groups in aquaculture production: quantity and emerging growth

Species group	2002	2005	APR
Top ten species groups in terms of quantity			
	Tonnes		percentage (%)
Carps and other cyprinids	16 727 667	19 541 921	5.3
Oysters	4 332 420	4 615 400	2.1
Misc. freshwater fishes	3 763 902	4 210 737	4.6
Clams, cockles, arkshells	3 458 226	4 175 907	6.6
Shrimps, prawns	1 495 950	2 675 336	22.2
Tilapias and other cichlids	1 490 573	2 025 560	10.8
Salmons, trouts, smelts	1 798 768	1 986 213	3.4
Mussels	1 634 280	1 795 779	3.2
Scallops, pectens	1 228 691	1 274 843	1.4
Misc. marine molluscs	1 389 586	1 107 395	-6.1
Top ten species group in terms of growth, 2002–2005			
	2002	**2005**	**APR**
	Tonnes		percentage (%)
Sea-urchins and other echinoderms	25	71 899	57 065.4
Abalones, winkles, conchs	2 970	333 947	2 619.2
Frogs and other amphibians	3 074	84 879	850.4
Freshwater molluscs	13 414	145 462	290.4
Sturgeons, paddlefishes	4 086	19 648	97.5
Cods, hakes, haddocks	1 450	8 194	80.0
Misc. aquatic invertebrates	12 593	61 756	77.8
Flounders, halibuts, soles	35 938	135 782	64.7
Miscellaneous coastal fishes	386 315	986 684	45.4
Tunas, bonitos, billfishes	9 745	22 915	37.4

TABLE 6
World fish farmers by continent (thousands)[1]

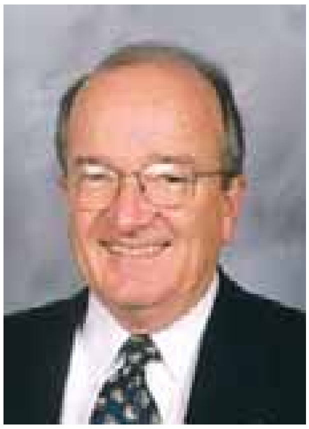
Continent	1990	1995	2000	2003	2004
Africa	3	14	83	117	117
North and Central America	3	6	75	62	64
South America	66	213	194	193	194
Asia	3 738	5 986	8 374	10 155	10 837
Europe	20	27	30	68	73
Oceania	1	1	5	5	4
World	3 832	6 245	8 762	10 599	11 289

[1] Data taken from SOFIA 2006; figures updated on 24 May 2007 by Camillo Catarci.

and molluscs within developing countries has exceeded the corresponding growth in developed countries, proceeding at an average annual rate of 10.0 percent since 1970. By contrast, aquaculture production within developed countries has been increasing at an average rate of 3.3 percent per year. In developing countries other than China, production has grown at an annual rate of 8.7 percent.

Five success stories in aquaculture

Wally Stevens



Executive Director
Global Aquaculture Alliance

Wally Stevens has worked in the seafood industry for more than 35 years, where he has taken on many challenges and held significant leadership positions. In 2007, he was appointed to the position of Executive Director of the Global Aquaculture Alliance (GAA) after his retirement from Slade Gorton & Company, Inc., where he held the position of President and Chief Operating Officer. One of the pioneers of aquaculture in the United States, Mr. Stevens was President of Ocean Products, a small salmon aquaculture company in the state of Maine. From 1970–1987, he worked at Booth Fisheries in several management positions. In 2001, Mr. Stevens was elected Chairman of the Board of the National Fisheries Institute (NFI); today, he is the Dean of the NFI's "Future Leaders" program. For the past year and a half, he has worked as one of the industry's leading proponents for free trade as President of the American Seafood Distributors Association (ASDA). Mr. Stevens graduated in 1962 from Plymouth State University and is active in Alumni Affairs. He is married to Meredith and has three sons.

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1. Shrimp: the most valuable seafood commodity from aquaculture

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ABSTRACT

Shrimp is the most valuable internationally traded seafood commodity. Limited fishery production and strong demand have stimulated rapid growth of shrimp aquaculture. From 1997 to 2004, farmed shrimp production grew at 15 percent per year to reach 2.5 million tonnes or 41 percent of total shrimp production. Leading shrimp-producing countries benefited from tropical climate and low labor costs. Another key factor was the ability to adapt quickly on a national level to implement infrastructure changes, adopt new technology, respond to market demands, and adjust to international trade barriers. Governments played a crucial role in providing enabling regulatory frameworks, technical assistance and financial assistance. Private-sector forces such as dominant feed companies, consolidation and integration processes, and strong producer associations also played a key role. The most important technological challenge has been viral diseases, which can cause catastrophic mortality, slow growth or reproductive failure. The primitive shrimp immune system lacks antibodies, which precludes the use of vaccines. Consequently, use of specific pathogen free stocks has become the method of choice to manage disease. Continuing technological advances in such areas as health management, genetic selection, nutrition and pond management are expected to further improve efficiency and reduce cost. Other challenges have included environmental, social and food safety issues. Recent reports of banned antibiotic residues and melamine contamination in China could lead to an unfavorable consumer reaction. Certification is gaining importance as a mechanism for international buyers to assure compliance with environmental, social and food safety criteria.

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Frank Asche is Professor of Industrial Economics at the University of Stavanger. He is also a member of the scientific advisory committee of the WorldFish Center and associate editor of Marine Resource Economics. His research covers all stages of aquaculture from an economic and business perspective, from the production process via issues in the value chain to the market and marketing of the seafood. The development of the salmon industry is a mainstay in his research, but he has also investigated issues in relation to other aquaculture species as well as wild fish. Dr. Asche has published a number of papers in academic journals, as well as more popularized articles in the trade press.

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2. Salmon aquaculture: production growth and new markets

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ABSTRACT

Aquaculture is distinguished from other aquatic production by the degree of human intervention and control that is possible. This control makes innovation possible and is accordingly essential for the rapid technological changes that have taken place since the early 1970s. Environmental conditions can be controlled to a large extent, breeding programmes undertaken and harvesting timed to ensure continuous supplies of fresh product. Salmon is among the most successful aquaculture species so far in that production has increased substantially as technology has become more intensive and industrialized. The control of the production process has also enabled a number of innovations in the supply chain making logistics and distribution more efficient. Moreover, its market has spread geographically and is now global, and new product forms enter the market in increasing numbers. Production is carried out in salmon-indigenous waters, as well as in areas where salmon is an exotic species, and the two largest producing countries (Chile and Norway) are located at the opposite sides of the world. In this paper we look closer at the processes that have made salmon a success story, with a particular focus on innovation. Moreover, we give special attention to Chile, which is today a leading salmon producer despite salmon being an exotic species in that region and long distances to the main markets

INTRODUCTION

Salmon is the most successful finfish species in aquaculture when measured in terms of value. The industry has grown from virtually nothing in the late 1970s to over 1.6 million tonnes in 2006. It is a global species, as Africa is the only continent without salmon aquaculture. However, salmon aquaculture is dominated by two countries, as Norway and Chile make up about 77 percent of the total production. There are several species being farmed, with Atlantic salmon as the most important, with significant quantities of coho and salmon trout and minor quantities of other species.[2] The growth

[1] Corresponding author.

[2] Salmon trout is large rainbow trout that competes in the salmon market. This is in contrast to the small portion-sized trout, which will not be considered here.

in salmon aquaculture has been possible because of a string of innovations that have increased productivity and reduced production and marketing costs, as well as creating new markets. In this paper we will look closer at the elements that have created the salmon aquaculture industry.

Aquaculture is distinguished from other aquatic production by the degree of human intervention and control that is possible. Anderson (2002) argues that the main difference between fisheries and aquaculture is the degree of control, and that the continuum of production modes stretches from a high degree of control in intensive aquaculture to basically no control in unregulated fisheries. Salmon has been at the forefront of this development and clearly shows how control with the production process enables innovations that increase its competitiveness. These innovations start with the input factors such as feed and vaccines, and are important throughout the supply chain from the production of the fish to the product that is sold to the final consumer. Since price, in most cases, is the most important argument with respect to which product in a group of products a retailer will stock, total production cost will be the main factor explaining the competitiveness of a product. By total production cost, one means the total cost of bringing the product to the consumer, which thus includes transportation, processing and marketing costs. Hence, after one has obtained control with the production process, innovations at one level in the supply chain are not more important than at other levels. What is important is their impact.

SALMON AQUACULTURE PRODUCTION

Salmon aquaculture became commercial in the 1970s, but production was tiny, and still as low as 13 000 tonnes in 1980. Total production and production of the most important species (Atlantic, coho and salmon trout), as well as the production of each species of the most important production countries are shown in Table 1. In 1985, total production had reached 80 000 tonnes, and Atlantic salmon's share of the production had increased to 64 percent from 50 percent in 1981. As production continued to increase, the share of Atlantic salmon also increased and in 2006, over 1.6 million tonnes of salmon were produced, with a share for Atlantic salmon of 77 percent. In 1981, salmon trout was relatively much more important than today, as a production of 7 000 tonnes gave a production share of 36 percent. Although production increased, the share was down to 24 percent in 1985 and 14 percent in 2006. Production of coho seems to have flattened out at about 120 000 tonnes, and today makes up about 7 percent of the total. However, it is interesting in Table 1 to note the important role of Japan in the mid-1980s. Moreover, please also note that in 1990, coho was the most important species in Chile, while in 2007 the quantity of Atlantic salmon is three times higher than that of coho.

TABLE 1
Salmon production (in 1 000 tonnes)

Species	Country	1985	1990	1995	2000	2005	2006
Atlantic	Canada	0.4	9.5	32.0	78.8	107.5	115.0
	Chile	0.0	9.5	59.0	167.0	385.0	369.0
	Norway	31.2	165.0	249.0	422.0	572.0	597.5
	United Kingdom	10.3	32.4	70.1	120.0	119.7	128.0
	Total	51.5	251.0	456.1	873.9	1245.9	1266.9
Coho	Japan	8.8	24.0	16.0	13.0	12.0	10.0
	Chile	0.5	13.4	44.0	93.5	106.7	108.1
	Total	9.5	39.4	60.5	108.2	121.2	120.6
S. trout	Chile	0.0	1.9	42.7	79.5	122.6	135.0
	Norway	5.2	3.8	14.7	49.0	59.5	57.0
	Total	19.0	38.8	93.4	177.3	226.1	239.0
Other species		0.2	0.2	13.3	13.7	17.6	27.2
Total		**80.2**	**342.4**	**623.7**	**1177.0**	**1620.4**	**1645.3**

Sources: FAO, Kontali Analyse.

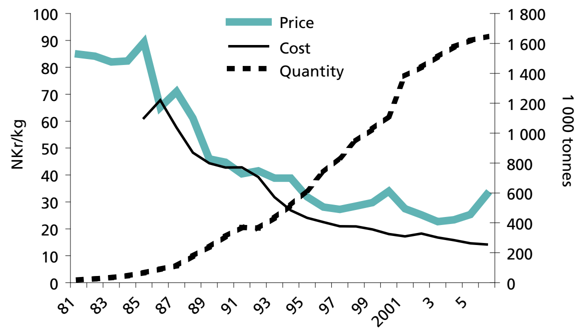
PRODUCTIVITY GROWTH AND LOWER PRODUCTION COSTS

Production of Atlantic salmon increased from about 20 000 tonnes in 1981 to about 1.65 million tonnes in 2006, and the Norwegian export price for fresh salmon in real terms declined from a high of over 85 NKr/kg in the mid-1980s via about 22.50 NKr/kg in 2003 to 32.70 NKr/kg in 2006. As the market for salmon is highly integrated, the price movement has the same main trends for Atlantic salmon from other producers, as well as for the other salmon species. It is also similar for sea bass, sea bream, catfish and tilapia, although the strength of the price decline varies (Asche, Bjørndal and Young 2001).

The decline in the price of salmon has been necessary to induce greater consumption of the product. For this to be profitable, production costs must also be substantially reduced. The main factors behind reduced production costs are productivity growth and technological change. Figure 1 also shows real production cost. One can see that both the price and cost have a clear downward trend, and the gap between them is consistently small. The average price in 2006 was about a quarter of the price in 1985, and the reduction in production cost is of the same magnitude. The important message here is that there is a close relationship between the development of productivity and the falling export prices.

The reduction in production costs has been due to two main factors. First, fish farmers have become more efficient so that they produce more salmon with the same inputs. This is what is normally referred to as the fish farmers' productivity growth. Second, improved input factors (such as better feed and feeding technology and improved genetic attributes due to salmon breeding) make the production process less costly. This is due to technological change for the fish farmers and productivity growth for the fish-farm suppliers. This distinction is often missed, and the productivity growth for the farmers as well as for their suppliers is somewhat imprecisely referred to as productivity growth for the whole industry. In addition, while the focus is on the production process, productivity gains in the distribution chain to the retail outlet are equally important. In the end, consumers are primarily interested in the final price for a product of any quality, and whether a price reduction is due to better feed or better logistics is of little importance. The most important input in salmon farming is the salmon feed, which represented around 52 percent of operating costs during 2004. The share of feed has been increasing (from about 25 percent in the mid-1980s), making the production process more feed intensive. Guttormsen (2002) suggests that substitution possibilities between feed, capital and labour have largely disappeared in the 1990s. This implies that the production process becomes one of converting a cheaper feed into a more desirable product for the consumers. A cost share of one factor, feed, at over 50 percent may seem high, but not when compared to other comparable industries such as pork and poultry production. For example, the cost share for feed for the most efficient poultry producers is over 80 percent. This suggests that there is still a substantial efficiency potential for salmon, and production costs can be further reduced if other factors are exploited even more efficiently.

FIGURE 1
Global aquaculture production of Atlantic salmon and real Norwegian export price 1981–2006 (2006=1) and production cost 1985–2006 (estimate 2006)



Source: FAO 2005, Fishstat database and the Norwegian Seafood Exports Council 2005.

MARKET GROWTH

When salmon aquaculture was commercialized in the 1980s, the markets were defined by where wild salmon was already sold. However, as production increased, the control of the production process allowed a number of innovations in logistics, transportation, marketing and product development. These have led to market growth as the market has been expanded geographically as well as in the number of product forms.

As production increased, pressure on the prices commenced and new markets were sought. There are substantial economies of scale in transport and logistics and accordingly, producers tended to target one geographical market at a time. The first target was France, a natural choice being the largest seafood importer in Europe, with one of the largest high-end markets. As the geographical area where the product was sold expanded, a number of innovations were made with respect to logistics, preservation and packaging. In particular, the development of leak-proof styrofoam packing allowed airfreight transportation. In the mid-1980s, the trade flow from Norway took a surprising turn as the United States became the largest export market after France due to the use of airfreight. The use of airfreight was important, as it to a large extent removed the barrier that distance had previously represented to a global market for fresh salmon. The geographical size of the market expanded as it became possible to reach virtually any place in the world with airborne salmon. It also allowed producers in any location to access the market, and this can be seen as the main factor behind Chile's success, now the largest salmon producer. The other main pattern has been to expand supply to markets where the freight can be carried out cheaply by road and to allow new sales outlets and product forms to be developed.

Another means of market expansion has been through introduction of new product forms. This implies creating new market segments. With the exception of smoked salmon and the Japanese market, virtually all product forms are fresh. For instance, in France in 1990 as much as 90 percent were sold as whole salmon to the consumer, while in 2000 the share of filleted and other prepacked product had increased to over 70 percent. In addition, salmon became increasingly popular in more value-added products, and there is currently a rapid expansion in the number of product forms available. A major step forward was made by Chilean producers in the early 1990s, with the introduction of the pin bone out fillet. Until then, the United States farmed salmon market had primarily been a market along the eastern seaboard, where whole salmon was presented in the seafood counters. With the pin bone out fillets, the Chileans opened a completely new market in the Midwest and attracted people who until then barely ate fish at all to consume substantial quantities. In fact, product development has been a main engine in Chilean market growth, and Chile currently seems to be the most market-oriented exporter.

How much salmon one is going to be able to sell at profitable prices will be determined as much by market growth as by productivity growth. To a large extent, this will depend on firms in the supply chain's ability to create new markets. As salmon is being sold in most countries in the world, expanding the geographical market is not really an option anymore. An alternative route is then to make the product affordable to consumers that could not buy it before by lower production and distribution costs, or one can create new product forms so that existing markets become deeper. Making salmon more affordable is a strategy that will work in some markets – most people outside the European Union, Japan and the United States cannot afford salmon today, even though prices have declined rapidly. A version of this, income growth that makes salmon affordable, will also help expansion. This seems to be a main driver behind the very high increase in consumption in Russia and Eastern Europe during the last few years. The largest potential may still be in further product development. The stable supplies of fresh fish at relatively low prices have, as noted above, given rise to an increasingly large industry producing value-added products based on salmon. If this process continues, there is a substantial potential for increased market growth here. In particular, in the most advanced markets one can increasingly observe prepacked salmon in counters presented in ways that more resemble chicken or pork than seafood.

Hence, the salmon industry from producers via distributors to retailers is increasingly becoming more like a food industry than a seafood industry.

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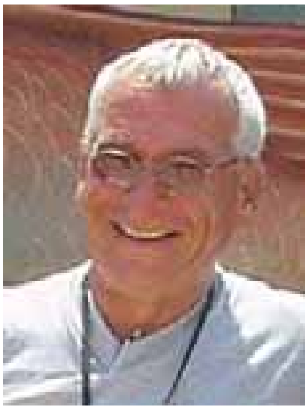
Israel J. Snir



Vice President for Technology and General Manager
Aquafinca Honduras
Regal Springs Tilapia

Israel J. Snir is Regal Spring Tilapia's Vice President for Technology and General Manager of Aquafinca Honduras. He was born in 1946 in Israel and is the father of nine children. Dedicated to tilapia since 1968, his first tilapia processing plant, Dag Shan, was built in Israel in 1977 and is still in operation. This was his first and pioneering attempt to convert tilapia farming to an established industry. He introduced fresh and frozen tilapia fillets to the markets in early 1980s. Since 1983, Israel has promoted tilapia culture, processing and marketing world wide. He has been involved in many projects around the world – the more important being in Jamaica, Israel, Africa, Colombia, Ecuador, the United States, Costa Rica and Honduras. For the past six years, he has worked in Honduras, where he manages the Aquafinca Company, part of the Regal Spring Tilapia group. In less then four years, Aquafinca has developed to become a world leader in fresh tilapia fillets. New production technologies, but more so, a unique social and environmental approach, are part of the technology used.

Regal Springs Tilapia – sustainability by social and environmental commitment

Israel Snir
Vice President for Technology and General Manager
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Regal Springs Tilapia

ABSTRACT

Tilapia is the common name for a vast number of freshwater fishes of the family Cichlidae. This is one of the largest families of fishes, containing more then 1 800 members, many of them in use in aquaculture. Members of the family range from very small ornamental species used in the aquarium industry to large food-size species raised in the fish-farming industry. Tilapia culture and production, mainly of foodfish, has been well documented over the years and appears in ancient documents, is drawn on old cave walls, and is part of the Biblical story. The cichlids, tilapias included, are distributed around the world on both sides of the equator. However, our interest is in the species originating from Africa and the Middle East. In both more recent history and in Biblical days, tilapia is mentioned as the "fish of the miracles" or the "fish for the people". Simultaneously and independently, the culture of tilapia as a common and basic food staple has been developed in various parts of the world. Compared to other cultured species, tilapia culture and consumption are the most widely spread worldwide. Salmon is produced principally by two countries and consumed mostly in Western developed countries and markets; carps are produced and consumed mainly by one country, China; catfish are produced by two or three countries and mostly consumed domestically; shrimps are produced by a few, mainly poor countries who can't afford to eat them, and therefore are exported and mostly consumed by rich populations in a limited number of countries. Tilapia is produced and consumed in over 100 countries and is a staple food for very poor people around the world; however, nowadays, it has also become a staple cuisine in the most expensive restaurants in luxury markets. In more detail, I will focus on a single system/company, the Regal Springs Tilapia group (RST). RST is the largest commercial tilapia vertical producer. This level of production and sales is reached by a nonconditional commitment to quality – of people, of culture, of the product.

Nguyen Huu Dzung

General Secretary
Vietnam Association of Seafood Exporters and Producers

Dr Nguyen Huu Dzung has been General Secretary of the Vietnam Association of Seafood Exporters and Producers (VASEP) – the leading nongovernmental organization in the seafood sector of Viet Nam – since its establishment in 1998. He is also General Director of the Vietnam Seafood Export Market Development Fund (SMF) and Editor-in-Chief of the "Thương Mại Thuỷ sản"[*Seafood Trade*] – a monthly magazine of VASEP. Dr Dzung has close relations with the industry and governmental agencies and a very rich international experience. Prior to taking up the position in VASEP, he was Deputy Director of the Department for Science and Technology of the Ministry of Fisheries (MOFI) and has worked with the Department since June 1984. Before joining MOFI, in 1971–1984, Dr Dzung worked as a senior lecturer for the National Fisheries University of Vietnam. Since working in MOFI, Dr Dzung has been closely involved with the programme for reforming regulatory legislation in the fisheries sector and has actively contributed in setting-up and strengthening the capacity of the National Fisheries Inspection and Quality Assurance Center (NAFIQACEN) – Viet Nam's competent authority in the fishery sector (now NAFIQAVED). He is currently responsible for improvement of quality and export of Vietnamese seafood to international markets and for development and implementation of standards ensuring quality, safety and hygiene in the seafood processing sector. Mr Dzung has a Bachelor of Mechanical Engineering from the National Fisheries University and a Ph.D. degree on Mechanical Sciences from the Lodz Technical University (Poland). He became an Associate Professor in 1992 and has conducted many training and educational activities for fishery inspectors, and the fishing and seafood industry. He has written hundreds of publications and articles.

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4. *Pangasius* – Viet Nam – fairy tale of an unknown species

Nguyen Huu Dzung
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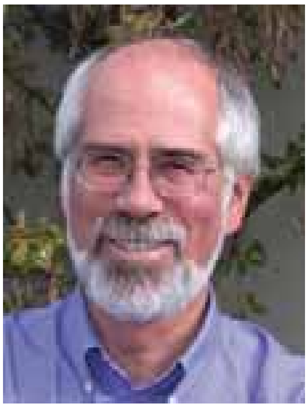
ABSTRACT

With the annual volume of live fish harvested in 2006 having reached 825 000 tonnes and an exported volume of frozen fillets and processed products of 286 600 tonnes valued at US$ 737 million, Viet Nam's farmers, processors and exporters have made *Pangasius* the second most important freshwater fish species in the world market, after tilapia. This report presents the wonderful development of the farming, processing and export of this fish during the past five years in Viet Nam. This fast upward trend has been kept in the first quarter of 2007, the export of *Pangasius* from Viet Nam in the first three months of 2007 reaching 80 851 tonnes valued at US$ 206 million, sustaining its high growth rates of 43.7 percent in terms of volume and 55.9 percent in terms of value as compared to the same period last year. Overcoming many technical and trade barriers in the United States and European Union markets, Vietnamese *Pangasius* has achieved a high position in the world and has become a bright phenomenon of the global aquaculture and seafood trade. This report analyses the production and market structure of *Pangasius* exported from Viet Nam during last year, and also highlights the main obstacles, challenges, opportunities and future development trends of sustainable production and trade of *Pangasius* of Viet Nam. It also presents outlines of VietGAP – a newly-developed, comprehensive standard for *Pangasius* production that is designed to be equivalent with EurepGAP and ACC standards.

Douglas McLeod



Chairman
Scottish Shellfish Growers

Doug McLeod has a background in resource economics, an expertise that has been applied in both his original professional incarnation in the international oil industry and now in his second career in the aquaculture sector. As well as operating a small-scale oyster cultivation operation in northwest Scotland, he is Chairman of both the national representative trade association, the Association of Scottish Shellfish Growers, a role he has carried out for almost 20 years, and of the trans-sectoral Scottish Aquaculture Training Association. He spends most of his time representing the interests of the shellfish cultivation industry in what is perceived to be a never-ending series of discussions with government officials, politicians, scientists and regulators across Scotland, as well as in London and Brussels. On the European scene, he is a Past President of the European Mollusc Producers' Association, the multi-national "association of associations" representing the European industry, and a Board member of AquaTT, the pan-European vocational training organization for the aquaculture industry. Internationally, he is a member of the Advisory Committee for the International Conference on Molluscan Shellfish Safety (ICMSS) and a voting member on the Toxin Task Force of the AOAC. In his spare time, Doug McLeod participates in shellfish-related projects, including recently MARINVEST, a technical consultancy to environmental and food hygiene Competent Authorities in China, as well as participating in a broad spectrum of conferences related to shellfish issues.

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5. Bivalves – success in a shell

Douglas McLeod
Chairman
Scottish Shellfish Growers

ABSTRACT

The historical development in global production by bivalve species is reviewed, noting the minor proportion of exports. The potential for future growth in international trade is discussed in light of two examples of recent export development (Chile and New Zealand). The need for agreed criteria for food safety standards (microbiological and biotoxin) and the failings in the current system are also discussed.

INTRODUCTION

The most outstanding characteristic of the bivalve mollusc sector in recent years has been the rapid and sustained growth in volumes – while capture fishery supplies have doubled from 1 million tonnes in 1970 to around 2 million tonnes in 2005, cultivated volumes have risen over the same period from 1 million tonnes to almost 12 million tonnes, forming a significant proportion of world aquaculture and representing some 26 percent of total output by volume and 14 percent by value.

During the past 15 years (the period of most rapid expansion) global production has risen at an average growth rate close to 6 percent per year. This dramatic growth is largely a reflection of the expansion in production in China, which rose from around 2 million tonnes in 1990 to 9.5 million tonnes in 2005, with Chinese production representing 80 percent of total bivalve aquaculture volumes in 2005.

The expansion in aquaculture production has varied between species, with the greatest increase being for clams. The pattern of output in 2005 was:

- oysters: 4.6 million tonnes (39 percent),
- clams: 4.2 million tonnes (35 percent),
- mussels: 1.7 million tonnes (15 percent), and
- scallops: 1.4 million tonnes (11 percent).

Aquaculture production, as a proportion of total supplies, has reached 90+ percent for oysters and mussels and 85 percent for clams; only in the scallop sector has the capture sector retained a significant role – reflecting the continuing extensive dredging industry – with aquaculture output at around 64 percent.

Drivers behind the global expansion include:

- recognition of the efficiency of filter-feeding bivalves in converting phytoplankton and nutrients into nutritious and high-quality animal protein;
- relatively low capital access requirements;
- frequently, the presence of a natural, low-cost source of seed;
- absence of feed costs for on-growing;
- relative ease of transport (no requirement for tanks, oxygenation etc);
- contribution to domestic nutrition (in contrast to the farming of high-value export "cash" crop finfish and crustaceans, molluscs are an accessible food supply across the planet!); and
- acknowledgement of the minimal environmental impact of bivalve aquaculture.

As filter feeders, feasting on the natural supply of nutrients from the oceans, bivalve molluscs are in reality not being "farmed" in the traditional, manipulative sense of the word, but are being cultivated or "arranged" in more optimal locations (e.g. suspended in the water column or organized in mesh bags and placed on trestles on the foreshore). The impact on the environment is essentially minimal. Indeed, molluscan cultivation differs from other aquaculture operations as being more subject to environmental influences than affecting the environment.

Bivalve exports are a relatively recent phenomenon, rising from 250 000 tonnes in 1990 to around 500 000 tonnes in 2005, and remain a minor proportion of most national production totals. Overall, exports amount to little more than 5 percent of total output, ranging from 16 percent for mussels and 6 percent for scallops to less than 2 percent for oysters and clams.

Success in breaking into international trade is not easy, requiring a combination of critical factors:

- availability of excess (to domestic demand) product;
- competitive pricing and transport systems;
- farmers' organizations and/or trade organizations to offset the disadvantages of traditionally small-scale production units; and
- access to agents in target markets.

TWO EXAMPLES

Chile

Despite the complexities and multiple criteria, bivalve aquaculture can be nurtured with exports in mind, as an instrument of economic development, in addition to supplying incremental nutrition for domestic markets, and two examples in recent years are Chile and New Zealand.

Aquaculture in Chile has grown rapidly in recent years, Chile becoming one of the top ten producing countries, contributing significantly to the economy, with around 69 000 jobs and US$1.8 billion in export earnings (some 60 percent of fishery sector exports), equivalent to 4.2 percent of gross domestic product (GDP). Exports enjoyed a record 25 percent increase in 2005, but now the industry is facing issues of rising costs and international competitiveness.

Production of mussels has risen strongly in recent years, to around 70 000 tonnes in 2004 (95 000 tonnes in 2005), and major investments are being made in the sector, both in production and processing, with the international markets the main target. This growth has been shadowed by a robust expansion in exports to some 18 000 tonnes in 2004. It should be noted that exports are mostly meats, frozen or canned, so it is necessary to uplift volumes by two to three times to compare with "green tonnes" of production volumes. These products are already reaching Europe, with bags of mussel meats retailing in European supermarkets at around € 6/kg.

Turning to another mollusc, abalone landings have also increased from 50 tonnes in 2000 to 205 tonnes in 2005, stimulated by export values of around US$ 24–30/kg. The overwhelming majority of abalone exports are destined for the Japanese market.

New Zealand

New Zealand combines low population, and therefore limited domestic demand, with an extensive coastline and unpolluted waters – these characteristics have supported a significant expansion in molluscan cultivation in recent years: for oysters, with natural settlement on "sticks"; and also for greenshell mussels in both North Island and especially the Marlborough Sounds of South Island, where there has been a rapid increase in sites and leases.

Production of mussels has trebled over the period 1990–2005 from 24 000 to 85 000 tonnes, driven by exports that have grown from 6 300 to 35 000 tonnes, from 26+

percent to 40+ percent of output (as mentioned previously, to compare these volumes with "green tonnes" of production, it is necessary to uplift volumes by a factor of two to three). Geography dictates that exports are largely in processed form, as exports are largely meats and half-shell products, and distributed world-wide, usually frozen.

Oyster production rose from 1 500 to 2 500 tonnes, while exports increased to around 2 300 tonnes, representing at least 80 percent of output and frequently in frozen form.

FUTURE OPPORTUNITIES AND CONSTRAINTS

There is clearly opportunity for further trade expansion, with China being an obvious candidate in view of its scale of production. But although the leading global producer, China barely registers on the international trade scene, with exports at < 50 000 tonnes or 0.5 percent in 2005. The Chinese market clearly absorbs virtually all domestic production (and some imports of around 6 000 tonnes).

Will this situation continue? Is there pent up pressure for exporting to satisfy markets like the EU? Will we experience an avalanche of molluscs onto the international market? Alternatively, will China increase imports to satisfy growing domestic demand due to economic growth? Chinese producers and processors certainly already have a wide portfolio of attractive products.

While overseas markets are an obvious attraction, with the EU representing a major food "magnet" attracting seafood supplies from around the world (Europe is the world's biggest net importer of fisheries products, and its dependency on imports is forecast to continue to rise), molluscan trade is constrained by detailed international shellfish safety regulations.

Major importers, such as the EU, Japan and the United States, have strict criteria on the environmental standards for shellfish cultivation areas as well as limits on the presence of contaminants for shellfish flesh. These criteria cover microbiological, chemical and biotoxin limits, with specific monitoring and measuring regimes, reflecting the established view that molluscs are a "high-risk" food. Any effort to expand the export trade must acknowledge these regulatory constraints; however there are on-going discussions about the relevance, accuracy and appropriateness of some of these criteria. It is rational to inquire: "Are they really for the protection of consumer health, or do they represent non-tariff barriers?"

The standard method of monitoring for biotoxins is the traditional Mouse Bioassay (MBA). However, the arguments in favour of retaining the MBA are being steadily eroded, with the advantages being outweighed by the disadvantages, both for paralytic shellfish poisoning (PSP) and even more so, for diarrhetic shellfish poisoning (DSP).

The development of alternative more accurate, chemical methods using techniques such as liquid chromatography/mass spectrometry (LC/MS) and high performance liquid chromatography (HPLC) should allow food safety authorities to move away from the dubious practice of the MBA to a more science-based methodology. However issues of cost and trained staff remain barriers in some countries.

With regard to microbiology, the identification of *Escherichia coli* as an effective indicator for viral contamination was a major public health breakthrough in the 19th Century, and while it may still remain reasonably accurate for urban areas, *E. coli* can no longer be considered an adequate indicator for remote rural areas. In fact, by using *E. coli* as an indicator, there is a positive correlation between remoteness and perceived pollution, reflecting the increasing efficiency in sophisticated urban water treatment plants, while rural areas generally have higher animal populations, whether domestic livestock or wild.

In my country (Scotland), the most isolated areas have high counts of *E. coli* because of the presence of eider ducks, seals, sea gulls, sheep and deer, none of which pose a great threat to human health, particularly after depuration which removes bacteria! It is clearly counter intuitive that harvesting areas surrounded by human habitation should have a better classification with regard to human health risk than remote areas.

As a result, I believe it will be essential for the successful growth of international trade in the mollusc sector that a more appropriate microbiological monitoring regime is designed and implemented as soon as possible, reflecting the lower risk to consumer health from bivalves produced in rural areas. This could perhaps be based on classification reflecting demographics (population per hectare), combined with on-going management (closures and re-opening of areas) based on rainfall in the catchment and/or salinity levels. Management systems like these are already in place and working effectively in New Zealand, avoiding the need for long-term closures as a result of diffuse rural "pollution".

In effect, management of environmental events and the impact on shellfish hygiene standards for the protection of human health should be a comprehensive risk assessment exercise, taking into account all the influences, accurately measuring contaminant levels in the shellfish and rationally assessing the effect of the contaminant levels (bacterial, viral, biotoxin, chemical) on human health.

I have deliberately not discussed prices or profitability, as comparing prices across time or products or countries is a statistical quicksand with a vast array of significant criteria and influences, ranging from size and specification, meat yield and appearance to position in the chain – farmgate, wholesale, retail – degree of processing and foreign exchange rate movements.

I believe that despite the wide range in example "pier head" prices for mussels, from US$ 100 in Chile to US$ 1 990 in Scotland, fundamental economics means that molluscs will only continue to be farmed if the price generates sufficient income for the farmer.

CONCLUSIONS

There are great opportunities for a future expansion in international trade in molluscs, requiring an acceptance of the need for hygiene regulations. However, any such regulations must be "fit for purpose", reflecting realities – they must be credible to both industry and consumer, and not act as non-tariff barriers.

Health regulations are essential, but they must be appropriate in method, accuracy, scope and frequency of application.

Regulators should ensure that risk assessment is the foundation of their management of molluscan production and international trade. Specifically, in the management of biotoxin events, a substitution of chemical methods for the MBA should be promoted strongly, and new approaches to microbiological safety in rural areas are clearly required to reflect the measurement of real risk. For any such risk assessment programmes to be effective, there must be clear communication between regulators and industry, and such communication must be acknowledged as an up-front priority, not a secondary issue after listening solely to researchers who are diligently searching for new toxins, creating more analytical methods or driving down the level of detection.

To enable the successful expansion in the international trade in bivalve molluscs – a remarkable food product with high nutritional values and a unique ability to contribute to economic development around the planet – it will be essential for government, regulators, scientists and industry to collaborate to a greater extent than has been evident in the past. And then we can all look forward to a prosperous and healthy future, for our industry and for our planet.