Selected sections for: Aquatic organisms as human food

Name

Aquatic organisms as human food

Common Names

English
Aquaculture products as human food

Issue: Key Topic Text

Aquaculture Products in the Human Diet

Fish - here taken to include all forms of seafood - is good food, contributing high-quality protein and important micronutrients to the human diet. As Figure 1 shows, fish consumption is especially high in parts of Asia.

Most fish is caught in the wild, from oceans, rivers, and lakes, but aquaculture is contributing a steadily increasing share of the world's fish supply. Fisheries production from all sources reached 133 million tons in 2002, of which 41.9 million tons was from aquaculture. The aquaculture production was worth more than US$50 billion (Vannuccini, 2004, p2).

More than 90% of this aquaculture production was in developing countries. China alone accounts for more than two-thirds of the world's total aquaculture production by weight, and more than half by value. If China were to be excluded, total world production of fisheries products at the turn of the century would have remained about what it was in 1995 (FAO, 2002a).

Thus aquaculture is making an important contribution to assuring food security in many parts of the world. The most widely accepted definition of food security is that adopted in the *Plan of Action* that emerged out of the World Food Summit of 1996:

> "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996, paragraph 1).

Food security is concerned with the food supply. Nutrition status, however, depends not only on suitable food but also on good basic health services and, particularly for children and the elderly, adequate care. Malnutrition generally results not from a lack of food in the community (limited availability) but from the skewed distribution of the food that is available. The skew results mainly because some people are too poor or too powerless to make an adequate claim on the food that is available (limited access).

Aquaculture can contribute to food security in three ways. First, aquaculture can improve the income of those who are in the business, either as owners or as workers, and thus improve their capacity to purchase foods of all kinds. Second, aquaculture can contribute to overall food supplies, and thus improve the quality and variety of food available to the population generally. Third, aquaculture can provide much needed food for those who are poor and thus particularly vulnerable to food insecurity and malnutrition. In this review we are concerned with the consumption value, rather than the commodity value, of cultured fish products, so we will focus on the second and third of these categories, the ways in which aquaculture affects the supplies of fish for consumption.

Aquaculture Products for the Population

Many fisheries have declined sharply or collapsed altogether in recent years, a phenomenon that is not visible in the grand

totals because other fisheries have been opened or expanded. There has been widespread overfishing in coastal and shelf areas, and also on the high seas. Fisheries are endangered not only by overfishing but also by pollution and other environmental stresses in spawning and feeding areas along the coasts. Overall marine production has been declining slightly, but there has been compensation in the rapid increase of inland production and aquaculture. Some of the deterioration is in quality rather than quantity, and shows up more in declining prices than in declining volumes.

The supply of fish available for human consumption increased to 16.38 kg per capita in 2000. However, with China excluded, the global pattern is one of reduction in supply, from 13.36 kg in 1995 to 12.75 kg in 2000 (FAO, 2002a). On a global basis, the share provided by aquaculture increased from about 0.71 kg of fish per person in 1970 to 5.87 kg in 2000 (FAO, 2003, p27).

With demand for fish outrunning supply, prices go up, and the increasing pressure on the resources means that often the environment is pushed beyond its limits of sustainable production. Future supplies are put at risk. Well-managed aquaculture can help to assure adequate supplies of fish for consumption, and can also help to protect the environment.

Aquaculture improves overall food security by adding high-quality products to the world's food supply, but there are conditions under which the quality may be questionable. This is discussed below in the section on Food Quality Issues. Also, there are conditions under which aquaculture operations may reduce the supply of fish and other foods available for human consumption:

> "The farming of carnivorous species such as salmon and shrimp, for example, requires vast quantities of wild-caught fish to feed confined stocks - indeed the norm is that two to five kilograms of wild fish biomass are required to produce a single kilogram of these high-market-value species" (Naylor et al., 2001, p1; also see Naylor et al., 2000).

Thus, some aquaculture operations may consume a larger quantity of fish than they produce, and thus reduce the overall supply of fish available as food. However, some observers point out that fish that are fed fishmeal are more efficient feed converters than land-based livestock (Tidwell and Allan, 2001).

Aquaculture Products for the Poor

On a per capita basis, people in developed nations have average supplies of about three times as much fish as people in developing nations. However, the people of developed nations also have more of other kinds of food, so they are not highly dependent on their fish supplies. Figure 2 shows the association between average income levels in different countries, measured as gross domestic product per capita, and dependency on fish, measured as the degree to which fish constitutes a share of the animal protein supply. Although poor people are not the biggest consumers of fish, they are most dependent on it. People in developing nations tend to be more dependent on fish in the diet than people in developed nations. The only developed nation for which fish provides more than 25% of the animal protein supply is Japan.

The fish supply per person in developed countries is almost three times that in developing countries not because of trade but because total production by developed countries is almost three times as high per person. Although fisheries exports play only a modest a role in distributing the world's fisheries resources between rich and poor, there is an 'invisible' fish trade in the form of livestock and related products. Large quantities of fishmeal and oil are transformed not only into pigs and chickens but also into other fisheries products through aquaculture operations.

It was pointed out above that some aquaculture operations are net consumers of fish. This may be defended on the grounds that they convert low-value products into high-value products. However, these operations may also shift the fish from consumption by low-income people to consumption by high-income people. There may be increasing value, but this benefit is likely to be concentrated on those who are already well off.

The transformation of low-value products into high-value products can mean a shift of food supplies away from the poor and to the rich, as is likely to be the case when, for example, mackerel and herring are used to feed bluefin tuna (FAO, 2003, p69). Consider what is being done in Chile:

> "In the case of one of the largest Chilean fisheries, for horse mackerel (*Trachurus murphyii*), the industrial fishery sector obtains 98% of the global annual quota. … The artisanal fishery for horse mackerel is an important source of local food security, whereas the industrial fishery transforms this fish into meal for animal feed (and takes a large bycatch of species important to the artisanal sector)" (O'Riordan, 2002, p39).

The demand for feed for raising fish and other livestock for the rich often outweighs the needs of those who cannot make adequate economic demands in the marketplace (Kent, 1995b).

Thus, aquaculture can either increase or reduce fish supplies for the local poor, depending primarily on whether or not it is export oriented. Aquaculture can also have harmful effects on other kinds of food production. For example, in India, export-

oriented shrimp production has adversely affected local rice production (Rigby, 1997).

There is also the danger that aquaculture operations might damage the surrounding environment:

> "Confining large numbers of fish in coast waters, especially in mangroves and wetlands, can also degrade the marine environment and threaten wild species by destroying nursery habitat, generating large quantities of nutrients and other wastes, importing diseases that can spread to wild fish, or allowing exotic species to escape and thus compete or hybridize with wild fish" (Naylor et al., 2001, p1).

Aquaculture may have contributed to the death toll from the massive tsunami in Asia on 26 December, 2004. One environmentalist argues that in Asia, "many mangroves have been cleared to grow shrimp ponds so that we, here in Europe, can have cheap shrimp," and those mangroves would have offered protection against tsunamis. He said the shrimps and prawns are sold to Europeans and other foreigners at a price that does not include the environmental cost (Fernando, 2005; also see Browne, 2004).

Development projects that focus simply on increasing overall food supplies by increasing productivity - whether in agriculture, fishing, or aquaculture operations - are not likely to contribute to increasing food security for the poor. New food supplies are likely to go to those who are better off. With increasing supplies, a nation's average per capita consumption level may increase while at the same time there is no increase in consumption by the poor. Fisheries products, like other foods, tend to move toward those who can pay for them.

Aquaculture can contribute to the food security of the poor either directly by supplying them with low-cost food or indirectly, by providing those involved in aquaculture production and marketing with an adequate income (Kent, 1995a; Tacon, 2001). However, aquaculture projects need to be designed specifically for this purpose, or they are likely to bypass the poor. The issues can be illustrated through examination of recent developments in China’s aquaculture.

China

Historically, China has suffered through extreme famines and widespread chronic malnutrition. It has been successful in combating these scourges. In its 2002 report on *The State of Food Insecurity in the World*, the Food and Agriculture Organization of the United Nations reported that China has reduced the number of undernourished people by 74 million since 1990-92 (FAO, 2002a). This is especially impressive when it is recognized that many other low-income countries have made little progress in reducing undernutrition during this period, or have seen the problem become worse. As the left side of Figure 3 indicates, the proportion of undernourished people in China, at 9%, is relatively small for a low-income country.

In 1999 China’s government claimed, "The food and clothing problem has been basically solved" (China Information Office, 1999). However, as we can see from the right side of Figure 3, the number of undernourished people in China remains over 100 million. China has more undernourished people than any other country except India (FAO, 2002a, Table 1). Although great progress has been made, undernutrition must still be regarded as a serious problem in China.

Fish is a highly valued component of the diet for many Chinese:

> "As their incomes continue to grow, China’s consumers are demanding more and more fish and seafood. Average per capita consumption rose from 5.2 kg. ... in 1998 to 5.8 kg in 1999, then again to 6.7 kg in 2000. Urban consumption - 11.7 kg per person in 2000 and growing - is almost three times that of rural areas" (Bean, 2003).

China is now the world’s largest producer of fish. It exports more fish than it imports, but even with its net exports its total supply of fish remains higher than that of any other country. Figure 4 shows that despite rapidly increasing exports, the supply of fish per caput has been increasing as well.

Figure 5 shows that since about 1980 in China, fish has accounted for an increasingly large share of the increasing per caput supply of animal protein. This increase is largely due to aquaculture production.

Aquaculture has always made an important contribution to China’s food security, by producing income and also by producing good food. The quantity of fish produced through aquaculture has increased rapidly since the 1980s so that by 2000, China was producing about 70% of the entire world’s aquaculture production by weight (Tacon, 2003).

Freshwater and marine aquaculture now account for about 60% of Chinese production of fish (Li, 2003), thus making an important contribution to food security in China. However, although China’s aquaculture development has been impressive, there are reasons for caution and concern with regard to its impacts on the food security of the poor in particular. Under some circumstances, aquaculture production can draw resources away from the poor, and redirect them to those who are better off

within the country, or to export markets.

1. The high demand for fish among those with higher incomes could reduce the supply available to those with lower incomes. This could show up, for example, as a strong flow of fish from rural to urban areas. This domestic pattern would echo the global pattern of world fish trade.
2. China's aquaculture is shifting steadily from its traditional form, concentrating on low-value products such as carp, to higher value products based largely on fishmeal and soy feeds. This could mean a reduction in the supply of low-value products for people with low incomes.
3. An increasingly large proportion of low-value aquaculture products is used as feed to produce high-value aquaculture products and other forms of livestock. Thus, the production of low-value products does not always benefit low-income consumers.
4. The shift to increasing production for higher income products is drawing labour away from agriculture and capture fisheries (Li, 2003), possibly reducing food supplies for the poor from those sources.
5. Like many other low-income countries, China exports high-value fish and imports low-value fish. However, increasing amounts of high-value fish products are being imported to meet the demands of people with high incomes.
6. Modernizing aquaculture in China may be associated with increasingly large-scale factory-like operations, resulting in greater income inequalities than were prevalent with large numbers of small-scale traditional aquaculture operations.
7. China's aquaculture might have an impact on food security in other countries. China has been importing large quantities of fishmeal to use as feed in its aquaculture operations. Although this fishmeal is sometimes described as being made from non-edible fish, these fish may in fact be an important part of the diets of poor people in the countries from which the fishmeal is imported
8. Under some conditions, export-oriented aquaculture may be an important means for assuring the livelihood of low-income people. To illustrate, in December 2004 it was reported that USA attempts to block imports of cultured shrimp from China "may threaten the livelihood of millions of Chinese shrimp farmers after the US door closes" (Zhang Jin, 2004).

These points, largely speculative at this stage, should be closely monitored.

Wealth in China is increasing rapidly, but poverty is not being reduced with corresponding speed, a paradox that results from the fact that much of the new wealth goes to those who are already well off. Increasing integration with the global economy and increasing wealth do not necessarily mean there will be comparable decreases in poverty (Khan and Riskin, 2001). Much can be learned from the experience of Mexico under the North American Free Trade Agreement, where "In the past decade in Mexico, the number of billionaires has multiplied and the incomes of working people have fallen" (French, 2004).

China's rapid economic growth in the past two decades has been accompanied by a sharp increase in inequality. Poverty remains widespread in rural areas, and it has been increasing in urban areas. Until the poverty problem is ended, the government must remain vigilant to be sure that those who become better off do not do so at the expense of those who remain poor.

The inequality in incomes means there is a corresponding inequality in food distribution. Although some analysts suggest that any addition to a country's food supply increases its food security, it should be acknowledged that these additions might not increase the food security of the poor. Most of the added food supply is likely to go to those who are better off.

Researchers at Shanghai Fisheries University (China) have examined the potentials for using aquaculture as a means for alleviating poverty among producers (Li, 2003). Little explicit attention has been given to the ways in which the products of aquaculture might help to improve the food security of the poor in the surrounding communities. At the least, precautions should be taken to assure that their food security does not worsen. As the prices to producers for low-value products such as carps weaken, production is likely to shift to high-value products, thus possibly reducing the availability of cheap food for the poor. Similar concerns arise in the Philippines for example, where there has been a shift away from the culturing of milkfish for local consumption to the culturing of shrimp for export (Hagler, 1997).

Attention is needed not only from researchers and producers, but also from policymakers. Policymaking regarding aquaculture in China has been driven primarily by concerns for generating income, improving overall food supplies, and assuring sustainability. The Ministry of Agriculture's "Guiding Instrument on Adjusting the Structure of the Fishery Sector" of 1999 illustrates this. Its central purpose regarding aquaculture was "to increase efforts to develop new markets and expand existing ones, increase the demand for fish through market promotion, develop new value-added products, improve the quality of aquatic products through technological innovation, provide improved infrastructure and facilities, and reform the legal system" (FAO, 2002b). No special attention was given to providing food for the poor.

Similarly, the National Bureau of Fisheries in the Ministry of Agriculture, which oversees aquaculture development in China, does not have an explicit mandate to address concerns about food supply (Song, 1999, Chapter 5). The Fisheries Law, promulgated by the Standing Committee of the National People's Congress in 1986 and revised in 2000, does not address the issue of food security for the poor (Anon, 1986; Anon, 2002). Since the first aquaculture policy statement included in *The Instruction to Broaden Policies to Accelerate Fisheries Development* issued in 1985, food security for the poor has not been an explicit concern

in policymaking for China's aquaculture (Song, 1999, Chapter 4).

Like the Shanghai Fisheries University researchers, China's policymakers have considered the potentials for aquaculture development as a means for leading farmers out of poverty, especially in the western regions (Song, 1999, Chapter 4). Although aquaculture surely can help to increase the incomes of poor producers, there is always the risk that poor producers will simply be displaced. Consideration should be given not only to the income that aquaculture can yield for producers, but also to the ways in which aquaculture products can be used to improve the food security of the poor as consumers.

Food Quality Issues

Consuming fish is good for one's health. It is a good source of readily digested high-quality animal protein. It is high in lysine and sulphur amino acids which make it particularly suitable for complementing the high carbohydrate diets prevailing in many less developed countries. It provides preformed vitamin A and vitamin D, and it is a good source of minerals (Kent, 1987, 29). Aquaculture products generally have the same good nutrient profiles as corresponding products found in the wild.

Like their wild counterparts, cultured products are vulnerable to contamination of various forms. For example, there have been cases in which cultured seafood products have been found to contain heavy metals because their feed had been contaminated (cf. Environmental Working Group, 2003).

Some aquaculture products, such as cultured salmon, have higher fat content than their wild counterparts. This may be of concern to consumers who want to limit their fat intake.

It is not only the quantity of fat that differs, but also the quality. Fish, especially marine fish, is a good source of omega-3 fatty acids, which are crucial in the human diet, especially for brain development, reproduction, and cardiovascular disease (Broadhurst et al., 1998; Crawford et al., 1999; Arts et al., 2001; Kris-Etherton et al., 2002; Leaf et al., 2003; Simopoulos and Cleland, 2003). However, concerns are emerging regarding the quality of cultured fish. One expert on fatty acids says of farmed fish, "If they're fed a grain diet instead of fish meal, they'll be abnormally high in saturated fat and linoleic acid and lower in omega-3 fatty acids - not what you want" (Simopoulos and Robinson, 1999, p153).

According to one report:

> "The fat in farmed salmon contains less healthy omega-3 fatty acids than the fat in wild salmon. Salmon fat is rich in omega-3 fatty acids, essential nutrients important to fetal brain development and linked to reductions in the occurrence or symptoms of autoimmune disease, headaches, cramps, arthritis, other inflammatory diseases, hardening of the arteries, Alzheimer's disease, and heart attacks. But USDA testing data show that the fat of farmed salmon contains an average of 35% less omega-3 fatty acids" (Environmental Working Group, 2003).

Elsewhere one finds claims that cultured fish have high levels of omega-3 fatty acids (Salleh, 2002; Hardy, 2003). The variability is due mainly to variations in the feeds used. Cultured fish has high levels of omega-3 fatty acids when the feed is composed primarily of fish, but the levels become lower to the extent that other sorts of feeds, such as grains, are used. However, if their diet is enriched with extra doses of omega-3 fatty acids, their flesh may contain even more omega-3 fatty acids than captured fish.

This may not solve the problem, however. The problem is not simply a deficiency in omega-3 fatty acid, but the fact that for many people the ratio of omega-6 to omega-3 fatty acids in the diet has become excessive. It is the ratio that is critical (Leaf and Weber, 1987; Simopoulos and Cleland, 2003). Some cultured fish may have higher levels of omega-3 than captured fish, but only because the cultured fish is more fatty overall. If the omega-6 level greatly exceeds the omega-3 level, cultured fish can make the ratio in the human diet even worse, despite the fact that the cultured fish has relatively high levels of omega-3 fatty acids.

For many people, the ratio of omega-6 to omega-3 fatty acids in the diet is too high, especially in richer countries. It has become too high largely because the production of beef and poultry has shifted from natural feeding methods (grazing) to industrial modes in which commercial feeds are used. These feeds have a high omega-6/omega-3 ratio, so the resulting meats have a high ratio as well.

The industrialization of fish production continues this process. Commercial aquaculture feeds generally have a higher omega-6/omega-3 ratio than that found in diets of wild fish. The large-scale shift to cultured fish in global fish production and trade, and the corresponding increase in the consumption of cultured fish, means that there is a need for caution to assure that cultured fish does not contribute to making the ratio worse than it already is in the human diet. If it is true that cultured fish tends to worsen the fatty acid ratio in the human diet, public policy should recommend that aquaculturists shift to feeds with better fatty acid ratios. This can be done by using more fish meal and less grain. If this shift is not achieved, it could become necessary to advise consumers against consuming cultured fish.

The Development of Aquaculture

The primary consideration in the design of new aquaculture projects is whether they can yield a profit. Thus we have many intensive aquaculture operations to serve high-income consumers, especially in export-oriented programmes (Kent, 1986). Largely because of the need to assure that the profit stream will be sustainable, there has been increasing concern about the environmental impacts of aquaculture programmes. Remarkably little attention has been given to the potential impacts of aquaculture projects on food security, especially for the poor. The national and international agencies that promote aquaculture development tend to focus on the product's commercial value, rather than its consumption value, because the agencies are more producer-oriented than consumer-oriented.

Although aquaculture is making a large and increasing contribution to the world's food supply, it should be recognized that many commercial aquaculture operations serve those who have the most spending power, not those who are most needy. Aquaculture activities, like food systems generally, are designed to maximize profitability, not nutrition status. It would be naive to assume that simply putting more food out into the world would alleviate malnutrition. Malnutrition is not caused by inadequacy in the supply of food worldwide, but by the inadequate purchasing power of the poor. Unless it is specially targeted, increasing volume is likely to improve food security for the rich and the middle class, but not for the poor.

Although profit-centered aquaculture may be the central interest of private investors, public agencies at the national and international levels should give special attention to the impacts of aquaculture programmes on the poor. Some aquaculture projects should be publicly supported because they help to alleviate the poverty of those who go into the business. They should also give close attention to their impacts on the food supplies of the poor.

In the absence of special measures, economic, social, and political forces will conspire to assure that the benefits gravitate toward those who are already well off. Thus, if aquaculture is to serve the poor, national and international funding agencies should consider these guidelines (Kent, 1995a):

1. **Increase funding for aquaculture for the poor.** A larger share of the funding available to support aquaculture activities (or fisheries activities, or development activities) should be specifically earmarked to activities designed to meet the needs of the poor. This means more support should be given to extensive, traditional, inland, and small-scale aquaculture operations.

2. **Do no harm.** Even if they are not designed specifically to serve the poor, aquaculture projects should do no harm to the food supply, income, or environment of the poor. This includes protecting aquaculture activities that already serve the poor effectively. To assure that harm to the poor is minimized and benefits are maximized, the local poor should be given greater voice in the design and selection of aquaculture projects.

3. **Strengthen existing aquaculture for the poor.** Rather than designing entirely new projects, there may be greater benefit from supporting what already works. Consider strengthening the property rights of the poor in existing operations, whether coastal or inland, or improving the marketing infrastructure in poor areas, or improving extension services.

4. **Produce low-cost products favoured by the poor.** Low cost is a necessary, though not a sufficient condition, to assure that the product will be consumed by the poor.

5. **Produce for local consumers.** Products destined for export, or even for distant cities, are not likely to be consumed by the poor. Focus on products likely to be consumed by the local poor.

6. **Encourage community production.** Although much of commercial aquaculture is based on privately owned operations, community-based production in local ponds and lakes can be effective in reaching the poor. Promoting production in open-access waterways can be useful as well. School fishponds can have high educational as well as nutritional value.

7. **Monitor food security and related impacts.** It should not be assumed that just because an aquaculture project is in a poor area and produces low-cost products the poor will in fact be the ones who get to consume the product. Test the assumption with field research. In general, assess aquaculture projects not only in terms of their economic and environmental impacts but also in terms of their nutritional impacts.

Projections for the future suggest that "aquaculture supplies a large share of the low-value food fish consumed by the poor, and that investing in improving the productivity and sustainability of low-value food fish aquaculture is a good way of making it more obtainable by the poor" (Delgado et al., 2002, p19). China's strong performance certainly indicates that intensive

aquaculture can be turned to serve low-income consumers on a large scale. Because shipping is costly, export-oriented aquaculture will continue to serve high-income consumers. Aquaculture's contribution to food supplies for the poor is likely to occur primarily through production for local consumption.

Aquaculture researchers give a great deal of attention to the nutrition of aquatic animals, but practically none to human nutrition. The framework of analysis should be expanded so that the ecological web under study goes beyond the pond and includes the human consumers and the society in which they are embedded.

Aquaculture is the most rapidly growing food production sector in the world. It is making a huge, high quality contribution to the world's food supply. With careful management of its environmental impacts and its impacts on the poor, its contribution could be even greater.

Related Library documents


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Related Case Studies

- Market channels for aquatic animal products in Hanoi, Vietnam
- Sydney rock oyster farming in Australia
- Working with the private sector in aquaculture development - the experience of GNAEP

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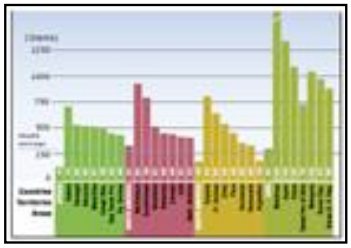
Title: Supply of fish

Caption: The supply of fish and fishery products in different countries.



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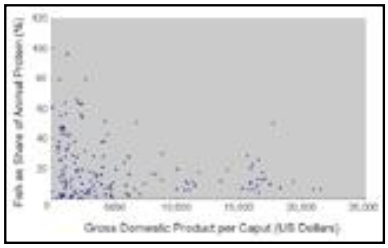

Title: Dependence on fish

Caption: Dependence on fish vs. income level.

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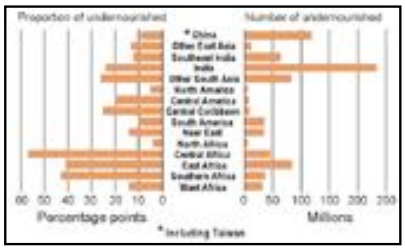

Title: Malnourished populations

Caption: Proportions and Numbers of Malnourished People.

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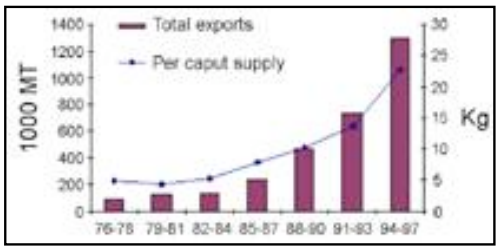

Title: Chin's fish exports

Caption: China's fish exports and per capita fish supply.

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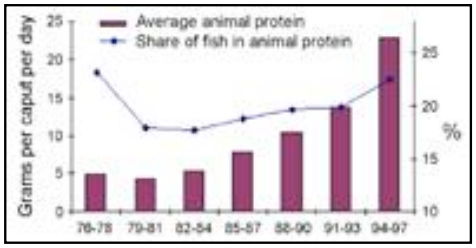

Title: Fish protein in diet

Caption: Fish as a share of China's animal protein supply.

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