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better nutrition better lives

Maximizing the contribution of fish to human nutrition

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Background

Hunger and malnutrition are the world's most devastating problems and are inextricably linked to poverty. A total of 842 million people in 2011-13, or around one in eight people in the world, were estimated to be suffering from chronic hunger, regularly not getting enough food to conduct an active life (FAO, IFAD and WFP 2013). The same report, The State of Food Insecurity in the World, notes that this is a slight improvement over the previous biennium but shows also that undernourishment and undernutrition coexist, where the quality of the diet does not allow for healthy growth and development. The challenges governments and international development communities need to address, given a global population that is projected to exceed 9 billion by 2050, much of it in developing countries prone to hunger, is to ensure both adequate food and nutrition security for all. It is widely acknowledged that fisheries has the capacity – if supported and developed in a regulated and sensitive manner that is both environmentally and socially responsible - to address the challenges and further contribute positively towards eradication of hunger, food insecurity and malnutrition. While the role of fisheries is increasingly recognized by national and global development policy makers, there is a clear need for a more proactive and concerted effort by the fisheries sector. At the global level, the ongoing work on the Post-2015 Development Agenda provides an excellent opportunity to reiterate and establish the importance of fisheries.

Historically the major focus of those engaged in the management of fisheries has been maximizing sustainable yields from capture fisheries and, since capture fisheries reached a plateau, to support the development of aquaculture. In recent years a more comprehensive eco-system approach to fisheries (EAF) has been elaborated (FAO 2011-2014). However, in all these discussions concentration on fisheries as a source of food for direct human nutrition has been rare. There are encouraging signs, however, that in 2014 the consumer is being put in the centre of the web. It is noteworthy that the increased attention to the role of fish in nutrition and food security resulted in both the sub-committees, (aquaculture and fish trade), of the FAO Committee on Fisheries (COFI), considering this topic at their recent meetings (FAO 2013, FAO 2014). This paper on "Maximizing the contribution of fish to human nutrition" is being considered by ICN2. In addition, concurrently a high level panel of experts, appointed by the United Nations Committee on World Food Security (CFS), has produced a report on sustainable fisheries and aquaculture for food security and nutrition (HLPE 2014). This will be debated at CFS 41 in October 2014.

In many low-income countries with water and fisheries resources, fish[1] is important for livelihoods, income and as food for the rural poor who suffer disproportionately from undernutrition, including micronutrient deficiencies (Thompson and Subasinghe, 2011). For these population groups, fish is by far the most frequently consumed animal-source and thereby makes a valuable contribution to the diversity of everyday diets, dominated by carbohydrate-rich staples. Fish can therefore be considered an irreplaceable animal-source, providing essential nutrients of

[1] For the purposes of this document the term "fish" embraces all living aquatic resources[1] that are used as food and derived from both capture fisheries and aquaculture in marine, brackish and fresh waters.

high bioavailability which are found in limiting amounts in the diet. These nutrients include animal protein, essential fats, minerals and vitamins. Small fish, eaten whole or as fish products, e.g. dried fish are particularly rich in calcium and other micronutrients. In recent years, through Scaling Up Nutrition and 1 000 Days, there has been focus on the role of fish as a rich animal-source food containing multiple nutrients for growth, development and wellbeing, and specifically as a source of essential fats for brain development and cognition in the first 1 000 days of life.

In considering how the contribution of fish to diets, particularly those of the poor, can be maximized, this paper first provides some general background information on fisheries production and fish consumption, then analyses constraints to increasing consumption and concludes by suggesting possible interventions. The paper concentrates on the direct contribution of fish to human nutrition, particularly of the poor and in terms of its contribution of macro- and micro-nutrients. It does not take into account the indirect contribution to sustainable livelihoods from employment in fisheries and increased income from sale of fish and fish products. The paramount issues of maintaining the sustainability of aquatic resources are noted but not covered in detail

Fish production and consumption

In recent years capture fishery production has been flat, at around 90 million tonnes per year, while aquaculture has continued to show sustained growth – currently around 6.5 percent a year - faster than all other food sectors (FAO 2012, FAO 2013 and FAO 2014). In 2011 it amounted to 62.7 million tonnes. Some gains in capture fisheries might be possible by adopting better management through an eco-system approach, but significant increases are unlikely. However, it has been estimated that if all inputs were available, aquaculture could provide 16 – 47 million additional tonnes of fish by 2030 (Hall *et al*. 2013). A comparison of capture fisheries and aquaculture production in the top five aquaculture producing countries in 2011 is given in Table 1. It is interesting to note that in four out of the five top aquaculture producers the output from aquaculture exceeds that from capture fisheries. Only in Indonesia, a vast archipelago is capture more than aquaculture.

A total of 156 million tonnes of fish was produced from all sources in 2011, of which 132 million tonnes was available for direct human consumption. Tacon & Metian (2009) show that fish is the most important animal-source food in the diets of more than one billion people. If equally distributed over the world’s population the annual per capita availability would be 18.9 kg (a strong increase from the 9.9 kg available in the 1960’s). However, as the 2009 data[2] presented in Table 2 (FAO 2013) shows consumption varies widely between regions: from 9.9 kg per capita in Latin America/Caribbean to 25.1 kg in Oceania. In more detail, the strongest difference is between industrialized countries, 27.4 kg, and low income food deficient developing countries (LIFDC’s), 10.3 kg, although this latter figure has more than doubled since 1961. Also within countries there is considerable variation, in most cases with the rich consuming significantly more. Whether a community eats fish is strongly ingrained in its traditional food habits. It is difficult to make fish

[2] At present, 2011 is the latest year available for complete FAO apparent consumption data for all countries in the world.

consumers out of those with no diet-linked cultural association. The pursuit of fisheries for food has obvious nutritional benefits but also, with at least 45 million people employed worldwide, the majority of them in developing countries, (including a large number of women employed mostly in processing activities); the income from fisheries contributes significantly to sustainable rural livelihoods and through them to improved nutrition.

TABLE 1 Capture fisheries and aquaculture production[3], together with fish consumption in the top five ranked aquaculture producers

COUNTRY Listed by rank of aquaculture production	**Capture Production**	**Aquaculture Production**	**Global Rank capture**	**Global Rank Aqua-culture**	**Capture as % aqua-culture**	**Annual Capture Growth 1990-2011 %**	**Annual Aqua-culture Growth 1990-2011 %**	**Fish Consumed Kg/head/yr (2011)**
CHINA	15.8	38.6	1	1	41	4.2	8.9	33.5
INDIA	4.3	4.6	5	2	94	2.1	7.4	5.2
VIETNAM	2.5	2.8	10	3	88	5.7	14.7	33.6
INDONESIA	5.7	2.7	3	4	210	4.0	8.4	28.9
BANGLADESH	1.6	1.5	15	5	105	4.4	10.4	19.7

Fishery resources are an important source of both macro- and micro-nutrients for humans. Globally fish accounts for about 17 percent of animal protein intake. This share, however, exceeds 50 percent in many countries. Despite the low overall African per capita consumption noted above, in West African coastal countries the proportion of dietary protein that comes from fish is very high: 72 percent in Sierra Leone, 55 percent in Ghana and Gambia and 43 percent in Senegal. Also in Asia and some small island states the contribution is high: 70 percent in the Maldives, 60 percent in Cambodia, 57 percent in Bangladesh, 54 percent in Indonesia, 55 percent in Sri Lanka (FAO 2012). Official data on fish consumption in developing countries may also be underestimated as these data fail to capture fish bought in small rural markets, as well as fish caught for consumption by household members or produced in home farms. In addition, fish consumption is affected by location, seasonality, time and household socio-economic status.

[3] Production in million tonnes excluding aquatic plants

TABLE 2 Total and per capita fish supply by region (2011)

REGION	Total food fish supply (million tonnes)	Per capita food fish supply (kg/year)
World	132.1	18.9
Asia	90.3	21.4
World excluding China	86.2	15.3
Africa	11.0	10.4
North America	7.6	21.7
Latin America/Caribbean	6.0	9.9
Europe	16.3	22.0
Oceania	0.9	25.1
Industrialized countries*	26.3	27.4
Low-income food deficient countries*	28.7	10.3

*Data for 2009

The central role that fish plays in the diet in some developing countries is exemplified by using data from Bangladesh. Data from the Household Income and Expenditure Survey 2010 showed that fish is by far the most frequently consumed nutrient-rich food group, followed by leafy vegetables, fruit, eggs, milk and meat (Bangladesh Bureau of Statistics 2012). In the 14 days preceding the survey, 71 % of households had consumed fish, whereas only 2 % had consumed meat. A summary of results from several consumption studies – national, different locations and seasons, from 1962 to 1999, in rural Bangladesh showed fish intake ranging from 15 g/capita day to 96 g/capita/day. Poor households had smaller fish intakes than rich households, and a larger proportion of the total fish intake was made up of small fish species in poor households compared to rich households. A large proportion of small fish is consumed as dried fish. The diversity of fish species consumption in Bangladesh is high, especially in rural Bangladesh. Survey data from four rural locations in 1992 showed that a total of 75 different fish species were consumed at household level (Thilsted 2012). However, reduced intake of diverse fish species, as well as a decreased proportion of small fish in total fish intake, has been reported with time. At the same time, with aquaculture expansion, intake of few, large farmed species: carps, tilapia (*Oreochromis niloticus*) and pangasius (*Pangasianodon hypophthalmus*) have increased throughout Bangladesh (Thilsted 2013).

An adequate animal protein supply can be obtained from other sources (e.g. meat from terrestrial animals) and there has been a tendency, as incomes rise, for the more affluent to increase their purchases from these sources. However, as they are generally more expensive than the cheapest fish the poor cannot make such life style choices and remain critically dependent on fish.

Traditionally the major focus of nutritionists was on the macronutrients providing energy and protein. Increasingly today the role of micronutrients - vitamins and minerals – in the diet, particularly of the poor, is recognized as having a limiting effect on development and health. Micronutrient deficiencies affect hundreds of million people, particularly women and children in the developing world. More than 250 million children worldwide are at risk of vitamin A deficiency, 200 million people have goitre and 20 million are mentally retarded as a result of iodine deficiency, 2 billion people (over 30 percent of the world's population) are iron deficient, and 800 000 child deaths per year are attributable to zinc deficiency. Rural diets in many countries are not particularly diverse, and thus, it is vital to have a good food sources that can provide all essential nutrients to their diets.

Foods from the aquatic environment are a complete and unique source of both the macro- and micronutrients required in a healthy diet. The benefits, as well as the potential risks, of fish consumption are well documented in the report of an FAO/WHO Expert Consultation on the risks and benefits of fish consumption (FAO/WHO 2011) that concluded that the benefits far outweigh the risks, which were principally from mercury and dioxins. The experts found convincing evidence of beneficial health outcomes from fish consumption for:

- reduction in the risk of death from coronary heart disease
- improved neurodevelopment in infants and young children when the mother consumes fish before and during pregnancy

It is the essential long-chain omega-3 fatty acid docosahexaenoic acid (DHA) that is important for optimal brain and neurodevelopment in children and eicosapantaenoic acid (EPA) that improves cardio-vascular health. Although many vegetable oils contain omega-3 fatty acids this is in the form of alpha-linolenic acid (ALA), which must be converted metabolically by chain length extension to EPA and DHA. However, the conversion from ALA into EPA and DHA is limited in humans, making it difficult to rely only on vegetable oil during the most critical periods of life. It has been demonstrated that the metabolic pathway in the human male is only 5 percent efficient, although the rate in females is higher, indicating a bigger requirement, (Burdge *et al* 2005). Omega-3 fatty acids in the form of DHA rather than ALA are therefore needed to secure an optimal brain and neural system development in neonates and infants. This is particularly important during pregnancy and the first two years of life (the 1000 day window).

Fish consumption also provides health benefits to the adult population. There is strong evidence that fish, in particular oily fish, lowers the risk of coronary heart disease (CHD) mortality by up to 36 percent due to a combination of EPA and DHA (FAO/WHO 2011).

In addition to the health benefits of these macro-nutrients fish is also an important provider of a range of micro-nutrients, not widely available from other sources in the diets of the poor. More and more attention is given to fisheries products as a source of micronutrients such as vitamins and minerals. This is in particularly true for small sized species consumed whole with heads and bones, which can be an excellent source of many essential minerals such as iodine, selenium, zinc, iron, calcium, phosphorus, potassium, vitamins A and D, and several B vitamins. There are significant variations between species and between different parts of the fish. Seafood is almost the only natural source of iodine, and iron and zinc are found in significant amounts, particularly in fish species eaten with bones, such as small indigenous fish species. Some of these small fish species, for example mola (*Amblypharyngodon mola*) have a very high content of vitamin A in the form of dehydroretinol and retinol. As most small fish are eaten whole, with bones, they are a rich source of highly bioavailable calcium (Roos *et al*., 2007). In addition, fish enhances the bioavailability of iron and zinc from the other foods in a meal (Aung-Than-Batu *et al*., 1976).

Data from a study in rural northern Bangladesh in 1997 showed that small fish intake met about 40 % of the vitamin A and 32 % of the calcium recommendations of an average household, in the peak fish production season (Roos *et al*., 2006). In Cambodia, a traditional daily meal of rice and sour soup made with the iron-rich small fish, trey changwa plieng (*Esomus longimanus*) can meet 45 % of the daily iron requirement of a woman. As the edible parts of large fish do not include the bones, viscera and organs, the micronutrient content is much lower than that of small fish (*Table 3*). For example, only 20 grams of trey changwa plieng from Cambodia contains the daily needs of iron and zinc for a child. Mola from Bangladesh, is reported to have a vitamin A level of > 2 500 µg RAE in 100 g of fish; based on a RDA of 500 µg for a child, 140 g of this fish will be enough to cover a child's weekly needs of vitamin A. (Roos e*t al* 2007) Table 3 gives the micronutrient composition of a number of small and large fish species from Bangladesh. Traditional wisdom among Bangladeshi women is that specific small fish species have health benefits including being: good for/protect eyes, full of vitamins, good for pregnancy and lactation, give strength and build up the blood.

Wild and farmed fish are a healthier alternative to almost any other meats. Farmed fish have a more constant nutrient composition compared to their wild counterparts, whose environment, food and access to food varies during the year. The environment of farmed fish can be monitored and managed to secure an optimal product. By controlling the composition of aquaculture feeds and other inputs, fish with good health and healthy fish products with optimal nutritional composition can be produced.

Table 3 Nutrient content of small and large fish species from Bangladesh

SPECIES	VITAMIN A (RAE/100g)	CALCIUM (mg/100g)	IRON (mg/100g)	ZINC (mg/100g)
Small indigenous species:				
Chanda (*Parambossis boculis)*	nd	1155	2.1	2.6
Darkina (*Esomus dondricus)*	880	775	12.0	4.0
Mola (A*mblypharynggodon mola)*	2680	776	5.7	3.2
Puti *(Puntius sophore)*	60	1042	3.3	3.8
Cultured species:				
Pangasius (*Pangasionodon hypothalamus)*	nd	8.6	0.7	0.6
Silver carp (*Hypothalamichthys molitrix)*	<30	36	4.4	1.4
Tilapia *(Oreochromis niloticus)*	<30	95	1.1	1.2
Dried Tuna frames	nd	8400	35	8.5

All contents except tuna frames are expressed as a percentage of the raw edible parts
RAE Retinol activity equivalent
nd - not determined

Innovative fish production technologies and other approaches to enhance the nutritional contribution of fish

In Bangladesh, innovative production technologies for increasing nutrient-rich small fish production have been developed for household ponds and wetlands. Building on the highly successful model of small-scale aquaculture practiced in Bangladesh, pond polyculture of carps and mola has resulted in a two fold increase in total fish production, of which mola contributed 31 % of total production. In addition to increased household income from the sale of fish, this production technology leads to higher intakes of vitamin A, calcium, and other micronutrients from consumption of mola. This approach is also being practiced in Terai, Nepal, West Bengal and Cambodia (Roos *et al*., 2007). Community-based sustainable management with enhanced stocking of mola in wetlands in north-east Bangladesh led to a threefold increase in total fish production, increase in fish species diversity from 49 to 68 and mola contributing 8 % of total fish production. Efforts are continuing to further increase the number of nutrient-rich small fish species in pond polyculture as well as in wetlands management. Building on the principles of nutrition-sensitive agriculture, strong nutrition education and awareness on the importance of small fish for improved nutrition to both female and male family members as well as participatory behaviour change communication to promote consumption of small fish, especially in women and young children have been integrated in pond and wetlands interventions (S.H. Thilsted, personal communication, October 2013).

Increased international trade of fisheries products has in many cases increased the amount of fish being processed, enabling the export of the higher valued parts. This leaves behind the less valued part such as heads, viscera and back-bones, representing between 30 and 70 percent of the fish after processing. In most cases these by-products are further processed into fishmeal and fish oil, primarily used for feed purposes and also indirectly contributing to food security. At the moment about 30 percent of the raw material for producing fishmeal and fish oil is based on by-products and waste rather than whole fish, this percentage is expected to continue growing (IFFO 2013) Fishmeal and fish oil are highly traded products, an important source of revenue for some countries, and a very important feed ingredient for the aquaculture sector, the fastest growing food production system in the world, as well as terrestrial meat production.

As more fish is being processed at an earlier stage and at an industrial scale, more of the waste or by-products can be processed into valuable products for direct human consumption. Although most of these by-products are presently not utilized for human consumption, international trade has in some cases opened up new markets for fish products traditionally not consumed in their country of origin. For example, there is a growing demand for fish heads as food in some Asian and African markets, a product not considered as food in other regions. Nile perch caught in Lake Victoria has for years been locally processed, and high value fresh fillets exported out of the region. By-products such as back-bones and frames became popular on the local market, and are now important products, traded at regional level.

From a nutritional point of view by-products might be of higher value than the main product, particularly in terms of essential fatty acids and micronutrients such as minerals and vitamins. The increasing demand for fish oil as a nutritional supplement has made it profitable to extract highly valued fish oil from by-products such as tuna heads. Mineral supplements can be made out of fish bones, although this is not yet widely done. A recent pilot production of a fish bone based mineral product showed high levels of most essential minerals, with e.g. 85 mg/kg of zinc, 350 mg/kg of iron and 84g/kg of calcium. The product was successfully mixed into traditional school feeding meals and highly appreciated by school children in Ghana (Glover-Amengor et al., 2012).

Recognising the role of dried fish in the diets of the poor, studies are being carried out in Bangladesh, through the CGIAR Research Program on Agriculture for Nutrition and Health, on the value chain of dried fish. Loss of nutrients as well as use of contaminants and additives at different nodes will be determined. The results will be used to design and introduce measures for improving the nutritional quality and safety of dried fish.

In response to the need for animal-source foods in the 1 000 days for cognition, growth and development, two unique fish-based products, using dried small fish species (a very concentrated source of animal protein, essential micronutrients and fats) have been developed: for women; dried fish with oil and spices, eaten as an accompanying dish to daily meals; for children; a pre-prepared instant product of powdered fish, rice, vitamin A-rich orange sweet potato and oil, to be served as a porridge. Development, distribution and acceptance of these two products will be field tested in 2014. Initial success will be measured by consumption patterns, and women's and men's perceptions of benefits; and ultimately, by improved nutrition and health in women, as well as growth and development in children.

The amount of the captured fish destined for non-food use has fallen from 34.2 million tonnes in 1994 to 22.8 million tonnes in 2009 (25.7 percent of the total). Out of this 17.9 million tonnes (20.2 percent of the total) was reduced to fishmeal and fish oil. The reasons for this decrease in non-food use of captured fish are variable; ranging from the increased use for human consumption and a decrease in dedicated feed fish catches due to tighter quota setting and additional controls on unregulated fishing. For example, there has been a notable increase of traditionally used feed fish (e.g., capelin, herring and blue whiting in Norway, herring and blue whiting in Denmark, jack mackerel and chub mackerel in Chile, anchovy in Peru) for human consumption. Specific reference may be made to Peru, where 190 000 tonnes (3 percent of the total catch) of Peruvian anchovy went for human consumption in 2009. Similarly in Norway, about 90 percent of the almost 1 million tonnes of Norwegian spring spawning Atlantic herring (*Clupea harengus*) caught in 2010 was used for human consumption. This trend is interesting and certainly increases the contribution of fish to human nutrition worldwide (FAO 2012).

Constraints to increasing consumption

The most obvious constraint to increasing fish consumption is availability at affordable prices to the poor. Scarcity as a result of population growth and demand has driven up prices and although aquaculture has contributed to closing the gap, the price of species from aquaculture tends to be higher than that of the small low-value species traditionally consumed by the poor. However, it is widely recognized that consumption of even small quantities of fish makes a significant contribution to the nutritional quality of the diets of poor people.

There is a persistently high volume of post-harvest loss that removes significant quantities of fish from the market – up to 25 percent in many developing countries. The reasons are varied and complicated but include: economics (lack of infrastructure, lack of access to credit) and lack of knowledge (limited education and no access to technology). There are physical losses because fish cannot be stored, additional losses when processing waste is not converted to edible byproducts and reduction of nutritional quality, caused by damage during storage and processing. Bycatches and discards of non-commercial species by capture fisheries also represent a very substantial loss both in developed and developing countries. Additionally the large volumes of small pelagic species that are converted to fish meal and oil for animal feeding potentially removes up to 25 percent of capture fisheries production from the human food supply. While at present their use in fish feed for aquaculture, which supplies 50 percent of fish for human consumption, is important, they could potentially also be converted to nutritious products, suited to low income consumers. However, efforts to date have been largely unsuccessful, principally because of lack of technology, unfavourable economics and the fact that they are not components of traditional food baskets.

Intensified rice production to feed growing numbers of people, particularly in Asia, has led to massive increases in fertilizer and pesticide application that have seriously reduced the availability of the many species traditionally available to the rural poor from rice-based aquatic ecosystems and associated water bodies. Damming of rivers for hydroelectric power production also impacts seriously on these resources. The incidence of micro-nutrient deficiencies in these communities has been exacerbated as a result.

Consumer safety of fish

In recent years there has been a lot of publicity on the potential risks from fish consumption, related to the presence of pollutants or contaminants. Much of this has been sensationalist but there are real problems that need to be faced not only with chemical contaminants but also with fish-borne diseases caused by poor hygiene and lack of effective food control.

In order to maximize the contribution of fish to human nutrition, not only the fish supply needs to be improved, but the consumer safety aspects need to be considered. In general, fish is considered a safe food and guidelines for safe production, handling and processing are available in the FAO/WHO Codex Code of Practice for Fish and Fishery Products (CAC/RCP 52-2003). However, even in the developed world it is apparent that these guidelines are not followed. For instance in the United States, from 2001-2010 there were 657 outbreaks of illness involving 5603 cases associated with fish and fishery products. Poultry was associated with 458 outbreaks involving 11, 338 cases, fresh produce with 696 outbreaks involving 25 222 cases and beef with 363 outbreaks involving 7528 cases (CSPI 2013). Most of the illnesses associated with fish were due to scombrotoxin (histamine and other biogenic amines caused by improper handling of certain species of fish) and ciguatoxin (toxin derived from certain microalgae found in many tropical areas of the world). In the EU, during 2011, 78.9 percent of the 71 outbreaks associated with fin fish were due to scombrotoxin and 4.2 percent were due to ciguatoxin. In the case of shellfish (crustaceans and molluscs), 40.5 percent of the 42 outbreaks in 2011 were due to calciviruses (noroviruses) and 16.7 percent were due to algal biotoxins (EFSA and ECDC 2013). In some parts of Asia, where there is a practice of consuming raw fish, human infestations caused by fish-borne trematodes (liver flukes) are commonly reported and there is some evidence that these are spreading to other countries through fish exports to migrant communities.

However, application of good hygienic practices (GHP) all along the postharvest supply chain, implementation of good aquaculture practices (GAP) during primary production and Hazard Analysis Critical Control Point (HACCP) based safety management in processing establishments; it is possible to improve consumer safety of both captured as well as farmed fish. Scombrotoxin formation in fish is due to temperature abuse and can be easily prevented by rapid cooling of fish immediately after harvest and adopting GHP all along the supply chain (FAO/WHO 2013). GHP would also be essential to prevent contamination by pathogenic bacteria like *Salmonella*. There are many pathways through which *Salmonella* can enter aquaculture systems and the measures that need to be adopted to minimize contamination of aquaculture systems with this pathogen has been recently documented (FAO 2010). In some countries, fish farmers may be constrained by the quality of water that is available for aquaculture, but the WHO Guidelines on safe use of waste water, excreta and grey water for aquaculture (WHO 2006) could be useful in ensuring that the water is safe for aquaculture. This guideline also covers measures that need to be adopted to minimize fishborne trematode infections.

Bivalve molluscs like clams, oysters and mussels are important source of nutrition for coastal communities with low income. Since these are filter feeding organisms, they tend to concentrate microorganisms and chemicals. The Codex Code of Practice for Fish and Fishery Products has a section on bivalve molluscs and improving their safety involves control of harvesting areas using sanitary surveys and biotoxin monitoring. Epidemiological records of outbreaks of illness caused by noroviruses (EFSA 2012) suggest that control of viruses requires additional measures. Codex Guidelines on Application of General Principles of Food Hygiene for the Control of Viruses in Food (CAC/GL 79-2012) would be helpful to countries to adopt such measures.

Possible interventions

Interventions to overcome the above constraints are wide ranging and will involve a number of actors including: international organizations, governments and civil society organizations, industry and academia. The theme of integration of efforts to reduce undernutrition is taken up in the State of Food and Agriculture (FAO 2013), which enjoins the entire food system – from inputs and production, through processing, storage, transport and retailing, to consumption to contribute much more to the eradication of malnutrition.

The issue of falling availability to the poor as a result of rising prices is an intractable problem that cannot fully be solved without accompanying efforts to reduce poverty. However, international agencies (FAO) should continue to assist governments by producing statistics on production and consumption, as well as carrying out projections and analyses of demand and prices. The role of governments is to monitor the situation and develop and implement appropriate policies and strategies, including ensuring linkages and synergies with macro-economic, nutrition and other related policies and requirements. Governments also need to provide adequate funding for implementing the policies and strategies. Funding must also be provided for educational efforts to ensure that consumers are aware of the specific nutritional benefits of fish products.

Reducing post-harvest losses and discards is technically an easier target but will require far reaching government interventions in policy change and investment in infrastructure. Before industry can be expected to invest in bringing the fish to market with efficient transport and functioning cold chains, government must fund the construction of landing centres and roads to link production areas to centres of population. Access to credit must be assured to encourage participation from small-scale operators and comprehensive educational and technology programmes are needed to change perceptions.

Additional efforts are required from all the stakeholders, including industry, research institutions, governments, universities etc. to develop the technologies and facilities for processing low-cost stable products from discards, material currently used for fish meal and waste from processing. In this context it is important to match product characteristics to local food habits. It is not enough to try to transfer products that are successful in one region to another.

Product development efforts must be accompanied by progress in substituting fish meal and fish oil in aquaculture feed, while preserving the unique nutritional properties of fish. This is a prime goal for industry and academic research and promising results are emerging, including the selection of genetically modified plants to produce EPA and DHA.

The reduction of availability of traditional food resources as a result of changing patterns of land use in aquatic eco-systems must be tackled in the first instance by giving the needs of poor rural people's nutrition a voice in national policy formulation, alongside rural development, agriculture, climate change, fisheries management and other related sectors.

More research and development of technologies (particularly in aquaculture) will also show results, as has been demonstrated in Bangladesh and Cambodia with small traditional species, rich in vitamin A and calcium, being grown in polyculture with high value fish. It is also essential that the population in general, but specifically pregnant women, be advised of the need for and sources of micro-nutrients, especially for infants. As an example of other ongoing interventions FAO is coordinating an EU-funded project assessing and evaluating the contribution of aquaculture to food and nutrition security (www.afspan.eu). This project is expected to generate much needed information and data on this important subject area through a comprehensive farm and household survey conducted in twenty countries worldwide.

The risks from chemical contaminants are best addressed by information rather than emotion. At issue are accumulation of heavy metals (Hg,Pb,Cd) as well as contamination of environment with dioxins and dioxin-like PCB's. As pressure grows to increase production on limited land there is an increased risk from the indiscriminate use of toxic pesticides. The available compositional data bases for aquatic foods lack good international coverage and figures they contain are often unreliable. An international cooperative programme to create accurate baseline contaminant and nutrient data bases would make future monitoring much more effective.

Keeping unsafe foods out of the food chain requires effective food control and inspection. While most countries now manage to apply an adequate level of inspection to their exports there are many instances when these controls are not extended to fish for domestic consumers. Thus those buying from local markets are potentially exposed to contaminants, parasites, toxins and microrganisms of public health significance. The risks are greater for the poor who must accept the cheapest product on offer. In addition to government efforts to implement fish inspection and food control there must be awareness programmes on safe food. These would include the needs for hygiene and food safety, accompanied by shellfish sanitation programmes and community action to clean up the environment of landing sites, transport, markets, restaurants, homes, etc.

Conclusion

In recent years, with dramatic rises and increased volatility in food prices, there is a risk that the diets of the poor will become even less diverse and more dependent on starchy staples. There is therefore a renewed emphasis on the production, access, distribution and utilization of common, micronutrient-rich foods Fish, especially nutrient-rich small fish, from the wild and from aquaculture, can play a vital role in improving human nutrition, but this will require changes to government policies, investment in infrastructure and encouragement of research. Means must be found to reduce post-harvest losses in fisheries, better utilize processing waste and to make use of the large quantities of small pelagic fish that are available for direct human consumption.

International organizations such as FAO, bilateral agencies such as USAID, through Feed the Future and DFID, the CGIAR through the CGIAR Research Programs, governments, NGOs and the private sector have all initiated programmes and interventions that provide a platform for fish to contribute to human nutrition. These should be further strengthened and coordinated.

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