Committee on World Food Security

High Level Panel of Experts on Food Security and Nutrition

The Role of Sustainable Fisheries and Aquaculture for Food Security and Nutrition

V0 DRAFT

A zero-draft consultation paper
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Submitted by the HLPE
to open electronic consultation

This V0 draft has been produced by the HLPE Project Team under guidance and oversight of the HLPE Steering Committee.

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This V0 draft is submitted for open e-consultation on our dedicated platform http://www.fao.org/fsnforum/cfs-hlpe/fisheries-and-aquaculture-V0 as part of the HLPE report elaboration process, for public and expert feedback and comments.

This consultation will be used by the HLPE to further elaborate the report, which will then be submitted to peer review, before its finalization and approval by the HLPE Steering Committee.

The final report is expected to be ready for publication in June 2014.

This V0 draft may be thoroughly corrected, modified, expanded and revised after the present consultation.

For this reason we invite you not cite or quote elements from this V0.

Please only refer to the final publication for quotations.

HLPE Cover letter for the V0 draft and e-consultation

In November 2012, the UN Committee on World Food Security (CFS) requested the High Level Panel of Experts on Food Security and Nutrition (HLPE) to conduct a study on The Role of Sustainable Fisheries and Aquaculture for food security and nutrition. Taking into account the results of the scoping consultation, the HLPE intends to assess the importance and relevance of Fisheries and Aquaculture for Food Security and nutrition as well as the current challenges faced by Fisheries and Aquaculture in relation to Food Security, pointing out changes going on, including overexploitation of fish stocks and the boom of aquaculture, in order to better understand these changes and to maximize the positive effects of them.

Final findings of the study will feed into CFS 41 Plenary session on policy convergence (October 2014).

As part of the process of elaboration of its reports, the HLPE now seeks inputs, suggestions, comments on the present V0 draft.

This e-consultation will be used by the HLPE to further elaborate the report, which will then be submitted to external expert review, before finalization and approval by the HLPE Steering Committee.

HLPE V0 drafts are deliberately presented – with their range of imperfections – early enough in the process, at a work-in-progress stage, when sufficient time remains to give proper consideration feedback received so that it can be really useful and play a real role in the elaboration of the report. It is a key part of the scientific dialogue between the HLPE Project team and Steering Committee with the rest of the knowledge community.

In particular, the HLPE would welcome comments and evidence based suggestions, references, examples, etc. on *policy aspects, from an evidence-based perspective*, on what can be done to improve the contributions of fisheries and aquaculture to improve food security and nutrition, now and in the future, in various contexts.

It is a fact: fish is nutritionally rich (in particular in bioavailable calcium, iron, zinc, and vitamin A); and fish (either produced through fish-farming activity or caught from wild stocks through fisheries) is used in many developing countries as a primary source of animal protein. The latest estimate by the FAO suggests for instance that in 2009, fish accounted for 17% of the global population's intake of animal protein and 6.5% of all protein consumed. Globally, fish provides about 3.0 billion people with almost 20 percent of their average per capita intake of animal protein, and 4.3 billion people with about 15 percent of such protein (FAO 2012).

Yet, fisheries and aquaculture are absent from most global reports on food and food insecurity (e.g., FAO SOFA and the FAO food insecurity reports) and, with some few exceptions, fish has so far been ignored in the international debate on food security and nutrition. At the same time, although the fisheries literature recognizes the importance of fish in relation to food security and nutrition, the analysis goes rarely beyond the simple adage stating that: "*Fish is a rich food for the poor"*.

There is an urgent need to go beyond this adage and establish more rigorously the link between fish ad food security and nutrition. The key-question that this study will aim to address is: "recognizing the well-established importance of fish to food security and nutrition, what should be done to maintain or even enhance this contribution now and in the long term, given the challenges that both fisheries and aquaculture sectors are facing in terms of their own environmental sustainability and governance, and the external economic and demographic transitions that they have to respond to?”

In order to address this overarching question, several more specific interrogations may be considered:

Respective contribution of fisheries and aquaculture to food security and nutrition: How and to what extent do fisheries and aquaculture contribute to food security - through which impact pathways? What is the evidence available to present fisheries and aquaculture as key ways for improving the food security of targeted populations?

Women and food security: What is the specific role of women in enhancing food security in fisheries and aquaculture sectors? What are the threats and barriers to this specific role and why and how should this role be strengthened?

Sectorial trade-offs and food security: Are there any trade-offs between the sectors’ contributions at different levels or between different groups? In other words, is it possible that enhancing food security at one level (or for one specific target group, e.g. urban consumers) reduces food security at another level (or for another specific group, e.g. fishers/producers)? As part of this issue, what is the overall contribution of international fish trade on food security?

Environmental sustainability of fisheries and aquaculture: Beyond an obvious long-term dependence, what is the relationship (trade-offs; synergies) between resource conservation and food security? In particular what are the short- and medium-term impacts of the large number of conservation interventions (e.g. marine protected areas) that have been recently established, on the local populations dependent on small-scale fisheries?

Governance and food security: What are the effects of the various management and governance reforms (e.g. co-management programmes) currently implemented at national level throughout the world’s fisheries, on food security? At the international level what is the role and impact of recent global programmes and campaigns such as the “International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU)”, or the implementation of BMPs (Best Management Practices) in aquaculture on food security?

Fisheries and aquaculture interaction: Are there any trade-offs between aquaculture and fisheries in relation food security? In particular is the use of fish meal (to feed farmed fish) a threat to human food security?

The future of fisheries and aquaculture in the context of foods security: What future role fisheries and aquaculture will be able to play in the context of the combined impact of demographic transition (increased population and increased living standard) and climate change (likely decrease in world agriculture production capacity)?

We thank in advance all the contributors for being kind enough to read and comment on this early version of our report. We look forward for a rich and fruitful consultation.

The HLPE Project Team and Steering Committee

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1. Introduction

1.1. Background

"*Fish is a rich food for the poor*". This adage, which is often very explicitly referred to in the fishery literature, reflects two widely accepted realities. One: fish is nutritionally rich. The presence of essential nutrients (in particular iodine, vitamin B12, vitamin D, essential fatty acids EPA and DHA (especially in marine fish), protein of high quality, and the very rich content in calcium, iron, zinc, and vitamin A is a well documented fact for which very little controversy exists in the literature. And two: fish (either produced through fish-farming activity -that is, aquaculture[1]- or caught from wild stocks through fisheries[2]) is used in many developing countries as a primary source of animal protein. The latest estimate by the FAO suggests that in 2009, fish accounted for 17% of the global population's intake of animal protein and 6.5% of all protein consumed. Globally, fish provides about 3.0 billion people with almost 20 percent of their average per capita intake of animal protein, and 4.3 billion people with about 15 percent of such protein (FAO 2012).

Yet, with some few exceptions, fish has so far been only marginally included in the international debate on food security and nutrition. In their recent review where they systematically assessed all the main methods applied by the leading agencies working in nutrition and food security Allison and his colleagues (2013, p.45) found that "fish is strikingly missing from strategies for reduction of micronutrient deficiency, precisely where it could potentially have the largest impact." .

Some would argue that the situation is improving and that the potential role of fish is progressively recognized outside the fishery literature. For instance, in the 100+ million dollar Consortium Research Programme "Agriculture for Nutrition and Health" launched in 2011 by the Consultative Group on International Agricultural Research (CGIAR), fish has been integrated as part of the component 1 on "Nutrition Sensitive Value Chains", along with traditional local foods, animal source foods, fruits and vegetables, bio-fortified staple foods, and processed foods. Far more could be done however to better integrate fish in these major nutritional interventions. This Nutrition Sensitive Value Chains component represents for instance only 10% of the total budget of the whole "Agriculture for Nutrition and Health" programme, while the Bio-fortification component is expected to absorb more than 50% of the total budget (CRP 2011). Ironically the objective of this Bio-fortification component is to "increased intake of iron, zinc, and vitamin A; and a resulting reduction in the prevalence of iron, zinc, and vitamin

[1] In this report fish-farming and aquaculture will be used interchangeably.

[2] While many of us still associate 'fisheries' to marine activities, a growing share of fisheries production come from inland fisheries. So 'fisheries in this report refers to both inland and marine (coastal and off-shore) fisheries.

A deficiencies" (CRP 2011, p.4), an outcome which can be done very simply and cheaply by adding fish (and vegetables) into the poor's plate.

It is in this context that in November 2012, the UN Committee on World Food Security (CFS) requested the High Level Panel of Experts on Food Security and Nutrition (HLPE) to conduct a study with the main objective to showcase "the importance and relevance of Fisheries and Aquaculture for Food Security" but also to "assess the current challenges faced by Fisheries and Aquaculture in relation to Food Security, pointing out changes going on, including overexploitation of fish stocks and the boom of aquaculture, in order to better understand these changes and to maximize the positive effects of them". The present report, entitled "The Role of Sustainable Fisheries and Aquaculture for Food Security and Nutrition", synthesizes the main conclusions of this analysis.

The presence, in the title of the report, of the term 'sustainability' reflects the premise that food security and nutrition *in relation to fish* cannot be achieved without the combined sustainability of the two sectors (fisheries and aquaculture). In that respect sustainability is regarded here as resulting from the combination of three intertwined and complementing dimensions: environmental, economic, and social and cultural dimensions. In essence, this means that the relation between sustainability (in its 3 dimensions) and food security (in its 4 dimensions: availability, accessibility, stability and utilisation) will provide the underlying structure of this study, and will also offer the basis for its problem statement.

1.2. Problem statement

Enhancing (or maintaining) the contribution of fisheries and aquaculture to food security and nutrition is not simply a question of ensuring the environmental sustainability of the two sectors. Keys to the discussion are some fundamental issues around access to, and distribution/allocation of resources, and the way these processes interplay with and/or influence (positively or negatively) the different dimensions of food security. Social and economic mechanisms and relations are key, and governance will ultimately appear as the overarching element shaping the relation between fish and food security. Governance often is silent on key dimensions relevant to food security, such as gender, nutrition, scale of operations or sustainability, underlining weaknesses and threats to the contribution fish can make to food security.

Several 'prisms' concentrate the tensions and highlight the unavoidable trade-offs that are to be made between the needs and interests of different actors or groups of actors, when it comes to maximizing the contribution of fish to food security and nutrition. These include the potential tensions between consumers and producers; but also the issues of direct versus indirect food security (i.e. self-consumption versus trade) both at intra-household, household and country level; the respective role that large-scale and small-scale operators play in food security and the negative impact that large-scale operations can have on smaller operators; the competition and negative externalities that can link fisheries and aquaculture; the impact of gender inequality on food and nutrition security; and the critical question of the trade-off between present and future food security in relation to the environmental sustainability of the sectors.

These 'prisms' will be used to explore and analyze more thoroughly the relations between fish and the four dimensions of food security. Whenever relevant, the gender dimension of these issues will be addressed within these chapters. However the key role that gender-relationships play in shaping food security and nutrition, especially in the fisheries sector, led the authors of the report to also add a specific chapter on gender.

The key-question that this report will address is the following one: "recognizing the well-established importance of fish to food security and nutrition, what should be done to maintain or even enhance this contribution now and in the long term, given the challenges that both fisheries and aquaculture sectors are facing in terms of their own environmental sustainability and governance, and the external economic and demographic transitions that they have to respond to, frequently in a gendered way?"

1.3. Structure of the report

To address this core question the report will be structured as follows: building on this introduction, chapter 2 presents some key definitions. The next chapter (Chapter 3) starts with a section reviewing the current knowledge on nutritional content of fish, and the health benefit that fish consumption generates. The conceptual model that was adopted throughout this report to 'capture' the different paths linking the ways wild and farmed fish are produced, traded, consumed, or even discarded, and the outcomes of these processes in terms of food security and nutrition of different groups of people, is then presented in section 3.2. A comprehensive discussion about these different paths and processes follows through a series of sections (sections 3.3 to 3.8), that highlights the state of knowledge but also the current areas where no consensus has emerged yet and debates are still prevailing. While section 3.3 presents the three core functions of fish as a food commodity the next (3.4) explores in greater details the question of the environmental sustainability of fisheries and aquaculture development, highlighting the challenge which is to respond adequately to the current and growing food security priority while at the same time avoiding irreversible impacts on the resource and the environment. Section 3.5 reviews in detail the contribution of the sectors at household level, highlighting the complex relation between direct (self-consumption) and indirect (cash generation) uses of fish and the consequences of this complex relation for food security at the household level. Section 3.6 reviews the current debate on the role of international fish trade on food security of different groups, presenting both the theoretical and empirical arguments found in the literature, while section 3.7 looks at the potential interactions between aquaculture and fisheries and discusses the effects that these interactions may have on food security and nutrition. Finally section 3.8 discusses the importance of considering the scale of the activity (small-scale versus large-scale fishing and/or fish-farming) and the implications that this scale has in relation to the abilities of the sectors to contribute to food security. Finally, by stressing the deeply gendered nature of fish-related activities (production, processing, trading) the next chapter (chapter 4) demonstrates the absolute necessity to adopt a specific gender-sensitive approach when one intends to tackle the fish-food security 'equation'. The next chapter (chapter 5) reviews and discusses in detail the role of governance. Arguably one could claim that governance is in fact the central element in this big picture and that every process, input and outcomes (from the initial access to the resources, to the way fish as a food commodity is marketed, used, and consumed) is ultimately shaped, created, amplified, or mitigated through some forms of governance. In the final chapter (Chapter 6) before the recommendations, the most recent 'projections' exercises available in the literature are re-examined from a food security and nutrition perspective. Chapter 7 presents the recommendations.

2. Definitions and concepts

2.1 The four dimensions of food security and nutrition

According to the 1996 World Food Summit (WFS) "Food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Four dimensions of food security are implicitly associated with this definition: availability, access, stability and utilisation (Table 2.1). These dimensions, and in particular the 'utilization' dimension, embody the food and care-related aspects of good nutrition.

Table 2.1. The four dimensions of food security and their determinants

Availability	Access	Utilization	Stability
• Domestic production • Import capacity • Food stocks • Food aid	• Income, purchasing power, own production • Transport and market infrastructure • Food distribution	• Food safety and quality • Clean water • Health and sanitation • Care, feeding and health-seeking practices	• Weather variability, seasonality • Price fluctuations • Political factors • Economic factors • Crisis and disaster e.g., fish disease outbreaks, natural and human generated disasters

Source: adapted from FAO

2.2 Fisheries

A fishery is defined in terms of the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, purpose of the activities or a combination of the foregoing features" (FAO glossary). Fisheries are often perceived or presented as the marine fisheries component of the sector, operating along the coast, lagoons and off-shore. Fisheries however also involve inland (freshwater) activities, on lake, rivers, reservoirs, floodplains, permanent or seasonal water bodies. Fisheries are harvested for their value (commercial, recreational or subsistence). As an economic activity, a fishery is characterised by its operational scale, ranging from small-scale to large-scale activities. What differentiates a small-scale fishery from a larger one is not necessarily clear and scale is often considered partly contextual; what constitutes a small-scale fishery in one country may be considered a medium scale fishery if operated in another. Some authors prefer to talk about a gradient running from small to larger, commercial fisheries. It is however possible to identify some generic characteristics of scale. Small-scale fisheries are characterized by 'low capital input' activities, low capital investments and equipment, labour intensive operations, and generally relatively low productivity. They also usually operate as semi-subsistence, family-based, enterprises, where a share of the catch is kept for self-consumption (Béné et al. 2007; Garcia et al. 2008; FAO 2012).

In view of their numbers and distribution throughout the world, small-scale fisheries are by no means 'small' in their aggregate. Nearly 90% of the world's ca.120 million full-time or part-time fishers are estimated to derive their livelihood from the small-scale sector – a huge source of employment. They are estimated to contribute 70% of the total world catch (inland fisheries included) which is used primarily for domestic human consumption (BNP, 2009; Mills et al., 2011). These figures also include those employed in the value chain (fish processing and trading), many of whom are women. The transformation stages of the value chain are estimated to employ nearly three times as many as the production stage (World Bank et al 2012). These figures, however, are most likely under-estimates as they derive from official statistics where small-scale operators are rarely well accounted for (Mills et al., 2011; Béné and Friend 2011; Kolding et al. in press). Small-scale fisheries are therefore an important, but underrated, source of employment, food security and income (Béné et al., 2010; Jentoft and Eide, 2011), particularly in the developing world and in rural areas (Allison and Ellis 2001; Neiland and Béné 2004; Béné, 2006; Allison et al. 2006; Menezes et al. 2011).

2.3 Aquaculture

As a parallel to fisheries, large and small-scale fish-farming activities are also remarkably diverse and locally specific, making their characterization also a challenge. Employment at farm level includes people operating hatcheries, nurseries, grow-out production facilities, and part time and occasional labours hired to work for aquaculture production. Employment at other links along aquaculture value chains include people working as input suppliers, middle traders and domestic fish distributors, processors, and exporters and vendors. In the case of the small scale operators, overall, like their fisheries counterparts most of these operators are characterised by low capital investments, low equipment and inputs, and low productivity (compared to larger-scale operations). They are often a family based activity, where part of the production may be retained for household-consumption (De Silva and Davy 2009, Subasinghe et al 2012).

Between 70-80% of aquaculture ventures are considered small scale (Subasinghe et al 2012).

The number of people employed in aquaculture varies from country to country, but recent data suggests that previous global estimates are a considerable under-estimate. FAO for instance indicated that there were about 10.7 million people "involved" in aquaculture in 2008 with the majority from developing countries, accounting for about 96% of the global total (FAO 2010). A more recent estimate derived from 10 case studies suggests that the number of people employed in global aquaculture would be close to 11.89 million full time equivalent jobs in these selected country case studies only. These case studies represent however just under 20% of the global aquaculture production. Extrapolation to the global production level suggests that total employment in global aquaculture value chains could be about 38.4 million full time persons (Phillips et al. 2013).

3. How does fish contribute to food security and nutrition – empirical evidence and current debates

3.1 Fish, food and nutritional value

Karawazuka (2010) recently compiled the data on fish nutritional content found in the literature, grouped into three categories: large freshwater fish, small freshwater fish, and marine fish (Table 3.1). For comparison purposes, the nutrient content of some other food items are also displayed. Shaded cells in the table indicate high content values.

Table 3.1: The nutrient content of fish and other foods (per 100g)[a]

	Scientific name/Common name (local name/common name)	Protein	Fat					Calcium	Iron	Zinc	Vitamin A	Notes	Source
			total lipid (fat)	total saturated	total poly-unsaturated	EPA	DHA						
	Units	g	g	g	g	g	g	mg	mg	mg	RAE[b]	per 100g	
large freshwater fish and prawn	Carp	17.83	5.60	1.08	1.431	0.238	0.114	41	1.24	1.48	9	raw, edible	1
	Catfish	15.60	7.59	1.77	1.568	0.067	0.207	9	0.50	0.74	15	farmed, raw, edible	1
	Channa striatus(Snakehead)		0.99	0.34	0.475	<0.001	0.133					raw, whole, Thailand	2
	Tilapia	20.80	1.70	0.77	0.476	0.007	0.113	10	0.56	0.33	0	raw, edible	1
	Macrobrachium nipponense (Prawn)		1.13	0.37	0.020	0.008	0.061					raw, whole, Thailand	2
small freshwater fish	*Amblypharyngodon mola* (Mola)							776	5.70	3.20	>2680	raw, edible. Bangladesh	3
	Esomus danricus (Darkina)							775	12.00	4.00	500-1500	raw, edible. Bangladesh	3
	Esomus longimanus (Chanwa phlieng)							350	45.10	20.30	100-500	raw, edible. Cambodia	4, 5
	Helostoma temmincki (Kanthtrawb)							432*	5.3*	6.5*	100-500	raw, edible. Cambodia	4, 5
	Puntius ticto (Puti)							992	3.00	3.10	500-1500	raw, edible. Bangladesh	3
	Rasbora tornieri (Changwa mool)							700*	0.70*	2.7*	>1500	raw, edible. Cambodia	4, 5
	Anabas testudineus(Climbing perch)		0.99	0.34	0.384	<0.001	0.088					raw, whole, Thailand	2
	Puntius brevis (Swamp barb)		0.90	0.31	0.314	0.000	0.047					raw, whole, Thailand	2
	Rasbora borapensis(Blackline rasbora)		0.86	0.33	0.319	0.002	0.083					raw, whole, Thailand	2
marine fish	Anchovy	20.35	4.84	1.28	1.637	0.538	0.911	147	3.25	1.72	15	raw, edible, Europian	1
	Herring	16.39	9.04	2.04	2.423	0.969	0.689	83	1.12	0.99	32	raw, eddible, Pacific	1
	Mackerel	18.60	13.89	3.26	3.350	0.898	1.401	12	1.63	0.63	50	raw, edibel	1
	Milkfish	20.53	6.73	1.67	1.840			51	0.32	0.82	30	raw, eddible, Philippinnes	1
	Sardine	24.60	11.45	1.53	5.148	0.470	0.509	382	2.92	1.31	33	canned in oil, drained solids with bone	1
other animal-source foods	Beef ground	14.30	30.00	11.29	0.696			24	1.64	3.57	0	raw, ground, 70 %lean meat 30 % fat	1
	Chicken breast	14.70	15.75	3.26	3.340			19	1.11	0.78	0	breast tenders, uncooked	1
	Chicken egg	35.60	9.94	3.10	7.555	0.004	0.037	171	3.23	1.11	140	raw, whole	1
	Chicken liver	16.90	4.83	1.56	1.306			8	8.99	2.67	3292	all classes, raw	1
	Cow milk	3.28	3.66	2.28	0.136			119	0.05	0.37	33	3.7% milk fat	1
plant-source foods	Cassava	1.40	0.28	0.28	0.048			16	0.27	0.34	1	raw	1
	Rice	2.69	0.28	0.28	0.323			10	1.20	0.49	0	white, long-grain, regular, cooked	1
	Kidney beans	8.67	0.09	0.09	0.278			35	2.22	0.86	0	mature, cooked	1
	Carrot	0.93	0.17	0.04	0.117			33	0.30	0.24	835	raw	1
	Kale	3.30	0.70	0.70	0.338			135	1.70	0.44	769	raw	1
	Spinach	2.86	0.39	0.39	0.165			99	2.71	0.53	469	raw	1
	High content:	>15.00			>2.000	>0.400	>0.400	>100	>3.00	>3.50	>500		

[a.] Data compiled by Karawazuka (2010).

Blank: no data available

[b.] RAE - Retinol Activity Equivalent

* Raw, cleaned parts

Reference: 1= USDA (2005); 2=Karapangiotidis et al (2010); 3=Roos (2001); 4=Roos et al (2007a); 5=Roos et al (2007b)

Macro-nutrients in fish

Protein

Protein from fish contributes to overall protein intake significantly as the digestibility of protein from fish is approximately 5-15% higher than that from plant-sources (WHO 1985). Furthermore, protein from fish helps absorption of that from plant-sources. Staple foods such as rice or maize contain little lysine, one essential amino acid, limiting the total absorption of protein. Lysine deficiency in grain-based diets leads to impaired growth and brain development in small children, and is associated with development of anxiety in grown-ups. In contrast, animal-source foods such as fish have more balanced concentrations of all essential amino acids, and the concentration of lysine is particularly high (WHO 1985). When fish is added into a plant-based diet, the total protein intake increases as lysine in fish compensates for the shortage of lysine in the rest of the diet. Fish play therefore an important role in plant-based diets in LIFD countries.

Lipids

The lipid composition of fishes is unique, having poly-unsaturated fatty acids (PUFAs) in the form of arachidonic acid (C20:4n-6), eicosapentaenoic acid (C20:5n-3), and docosahexaenoic acid (C22:6n-3), with many potential beneficial effects for adult health and child development (Thilsted et al. 1997). The amount of PUFAs in large freshwater fish such as carps and tilapia is relatively low, while that of many smaller indigenous species is yet to be determined. Among fish species which are cheaper and traded in developing countries small pelagic forage fish such as anchovy and sardine, are perhaps some of the richest sources of PUFAs (USDA 2005).

Fish intake influences the PUFAs levels in breast-milk of lactating women. In China the level of docosahexaenoic acid in breastmilk of women living in coastal regions has been shown to be higher than in other regions (Ruan et al. 1995). Similarly in Tanzania, women with high intakes of freshwater fish had levels of arachidonic acid and docosahexaenoic acid in their breast-milk that were above the present minimal recommendations for infant formulae (Musket et al. 2006). However, it is still not clear how the PUFAs in breastmilk contribute to foetal and infant development, and further investigations are required into the quantities and nutritional significance of the fatty acids in fish species commonly consumed by the poor (Roos et al. 2007a; Dewailly et al. 2008)

Small fish as a source of micronutrients

In addition to being an important source of animal protein and PUFAs, the high nutritional value of fish (in particular small fish) in terms of essential micronutrients - vitamins D, A and B, minerals (calcium, phosphorous, iodine, zinc, iron and selenium) has been well documented in the literature (Roos et al. 2003; Roos et al. 2007a; Bonham et al. 2009) (Table 3.2). Recent research suggests that small fish species that are consumed whole with bones, heads, and viscera play a critical role in micronutrient intakes as these parts are where most micronutrients are concentrated, and the potential contribution that fish (even in small quantity) can offer in principle to address multiple micronutrient deficiencies in developing countries is now being increasingly recognized –at least in some parts of the literature (e.g. Roos et al. 2007b; Karawazuka and Béné 2011; Thilsted et al. 1012). Outside the fishery-related literature however, the contribution of fish to FSN is still extremely poorly acknowledged.

Table 3.2. Typical nutrient composition of fresh water and marine fish (both lean and fatty). For all except anchovy, only the fillet is eaten. Anchovy is eaten whole with head and bone, supporting a better mineral composition than the others.

	Pike (lean fresh water)	Tilapia (fat fresh water)*	Sprat (fatty marine)	Seabass (lean marine)	Anchovy (eaten whole)
Eatable portion, %	53	50 - 60	68	40	100
Vitamin A, µg	9	?	60	9	57
Vitamin D, µg	0.9	?	18.7	0.8	0.2
Vitamin E, alfra TE	0.7	?	1.2	1.2	0.6
Tiamin, mg	0.07	?	0.08	0.07	0.02
Riboflavin, mg	0.07	1.3	0.15	0.07	0.16
Niacin, mg	4	2	4.7	4	2.2
Vitamin B6, mg	0.1	?	0.2	0.1	0.5
Folate, µg	9	?	9	9	5
Vitamin B12. µg	24	?	7	5	10
Vitamin C. mg	3	?	0	0	0
Calcium, Ca, mg	44	24	47	110	99
Iron, mg	0.6	31.9	0.8	0.6	1.3
Phophorous, mg	205		120	240	141
Magnesium, mg	28	1.7	16	26	13
Zink, mg	1	51	0.9	0.8	1.8
Selenium, µg	22	?	10	28	20

*study from Ghana by Steiner-Asiedu (1989)

**all species sufficient in EPA/DHA to meet demand for brain development if included in the diet regularly (USDA, 2013)

***all species protein held a balance of essential amino acids equal to other animal protein

Some caveats apply to this broad brush assessment. First, the majority of the studies that propose to quantify fish micronutrient content of fish eaten in developing countries have been conducted in Asia (essentially Bangladesh and Cambodia). Far less is known about species in other parts of the developing world, and especially in Africa. It is also the case that different fish have different nutritional qualities (e.g. 'white fish' and 'oily fish') (cf. Table 3.2) and these may also vary for farmed fish cultured differently, e.g. with different feeds.

Secondly, while fish intake does increase a person's animal protein intake and perhaps also essential micronutrient and fats content of a person's diet, this does not necessarily mean that the nutritional status of that person will improve or can be measured (Kongsbak et al. 2008)[3].

[3]

Finally, being highly perishable, fish needs timely harvesting and procurement, efficient transportation, and advanced storage, processing and packaging facilities for its marketing. In particular, specific requirements and preservation techniques are needed in order to preserve its nutritional quality, extend its shelf-life, minimize the activity of spoilage bacteria and avoid losses caused by poor handling (Gram and Huss, 1996; Huss et al. 2004; Adams and Moss 2008). The contribution of fish to micronutrient intakes is determined therefore not only by the nutrient content of the species but also by the local processing methods and eating patterns. As a consequence, several studies recalculated the actual nutrient content of the edible part by reflecting the local methods used to clean and prepare the fish for the meal (e.g. leaving or cutting off the head, removing a part of viscera) and correcting the calculations to account for plate-waste after the meals (Chamnan et al. 2009; Roos et al 2007a,b,c,d).

3.2 Fish and health

Even if the links between micronutrient status and functional outcomes can be difficult to establish there is an increasing literature on the positive impacts of fish. Where its rich nutrient content is preserved (essentially through high value chain processing such as these found in developed countries), fish can provide protective effects on a wide range of health issues, e.g. where obesity, incidence of stroke, high blood pressure, and coronary heart disease and malnutrition co-occur through too high an intake of energy combined with a lack of balanced nutrition (Allison et al. 2013; arsen et al. 2013, Miles and Calder 2012; Rangel-Huerta et al. 2012), and possibly cancer – although the mechanisms through which these different effects function are still poorly understood.

On the other hand, the risks of toxins/poisoning from harmful algae are still problems in some parts of the world (e.g. Asia and the Pacific). Little is known about the impacts, likely to be increasing, of heavy metals and other chemical pollutants on fish, but these are likely to be increasing along with their use (STAP 2012). When considered together, experts tend to agree however that the positive effects of high fish consumption largely overcome the potential negative effects associated with contamination risks (see e.g. Mozaffarian and Rimm 2006; FAO/WHO 2011, Hoekstra et al. 2013).

In poor countries where high levels of cereals, starchy roots (e.g. cassava), tubers (all low protein diets) are eaten, the challenge is shortage in both energy and other essential nutrients, resulting in illness caused by deficiency. The lack of essential nutrients, e.g. minerals such as Ca, P and Mg, leads to developmental errors (skeletal and muscular weakness / deformity); small fish eaten with head and bone will secure the intake of these minerals, and therefore could be an important part of a healthy diet. Anaemia caused by lack of iron is the most common nutritional disorder in the world, occurring mostly in women (menstrual losses) and children. Iron deficiency can also be a problem in fishing communities, however, due to extreme poverty. For example, in India more than 70% of the fisherwomen in the coastal communities of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu were anaemic, even though they spent about 60% of their earnings on food. In terms of nutrition and education, discrimination against girls varied with the educational level of parents and was least in Kerala, where literacy levels for both women and men are higher than in other parts of the country (Khader et al 2006).

In children often a combination of copper and iron deficiency exists; both these minerals are well balanced in fish. Fish will also contribute with zinc, being essential for wound healing and the immune system, and where starchy food is almost deficient in zinc. Together with all animal protein, fish protein is of high quality, holding essential amino-acids; thus, including fish in the diet will help prevent protein and energy malnutrition (PEM), if ingested in sufficient quantity. Disease caused by PEM occurs especially in children before the age of five. Nutritional deficiency affects various components of the immune system, whereas sufficient protein of high quality (animals including fish) will result in increased resistance to infectious diseases.

With respect to lipids, the fatty acids, EPA and particularly DHA, are major building blocks in the human brain. These are abundant in the marine food chain, but also sufficient in fresh water fish to contribute to normal brain development and function (USDA 2013). Especially in children there is a critical 1000-day window where these need to be sufficient to hinder developmental disorders, in this concept fish will be of importance. There is presently a lot of focus on animal-source foods, including fish, in the first 1,000 days of life – not only as a source of vitamins and minerals, but also as a source of essential 3 fatty acid for brain development and cognition (Zatsick and Mayket 2007; Zheng et al. 2012). Although babies between 0 – 6 months should be exclusively breastfed, the potential role of fish in the nutrition of pregnant and breastfeeding women makes the concept of 1000 days quite appropriate for this discussion.

3.3. Pathways to food security and nutrition

The relation between fish and food security and nutrition (FSN) is complex. It involves many different dynamics combined into several 'pathways' and linked through different trade-offs and dynamics operating at different levels - from households to macro, global levels. Fig.3.1 represents conceptually these different pathways and how they are linked together to 'deliver' FSN.

The three core functions of fish as a food commodity

Certainly the first (and possibly most important) of these dynamics is the trade-off that has to be made between the different uses of fish. These uses can be broadly related to three core functions of fish as a commodity: (i) fish for food, (ii) fish for feed, and (iii) fish for cash (these three uses are represented in red in Fig.3.1). We are claiming that this first 'triage' where decisions are made on how fish will be used with respect to these three functions is instrumental as it will determine which FSN pathway fish will take and eventually how this will affect the different dimensions of food security and nutrition.

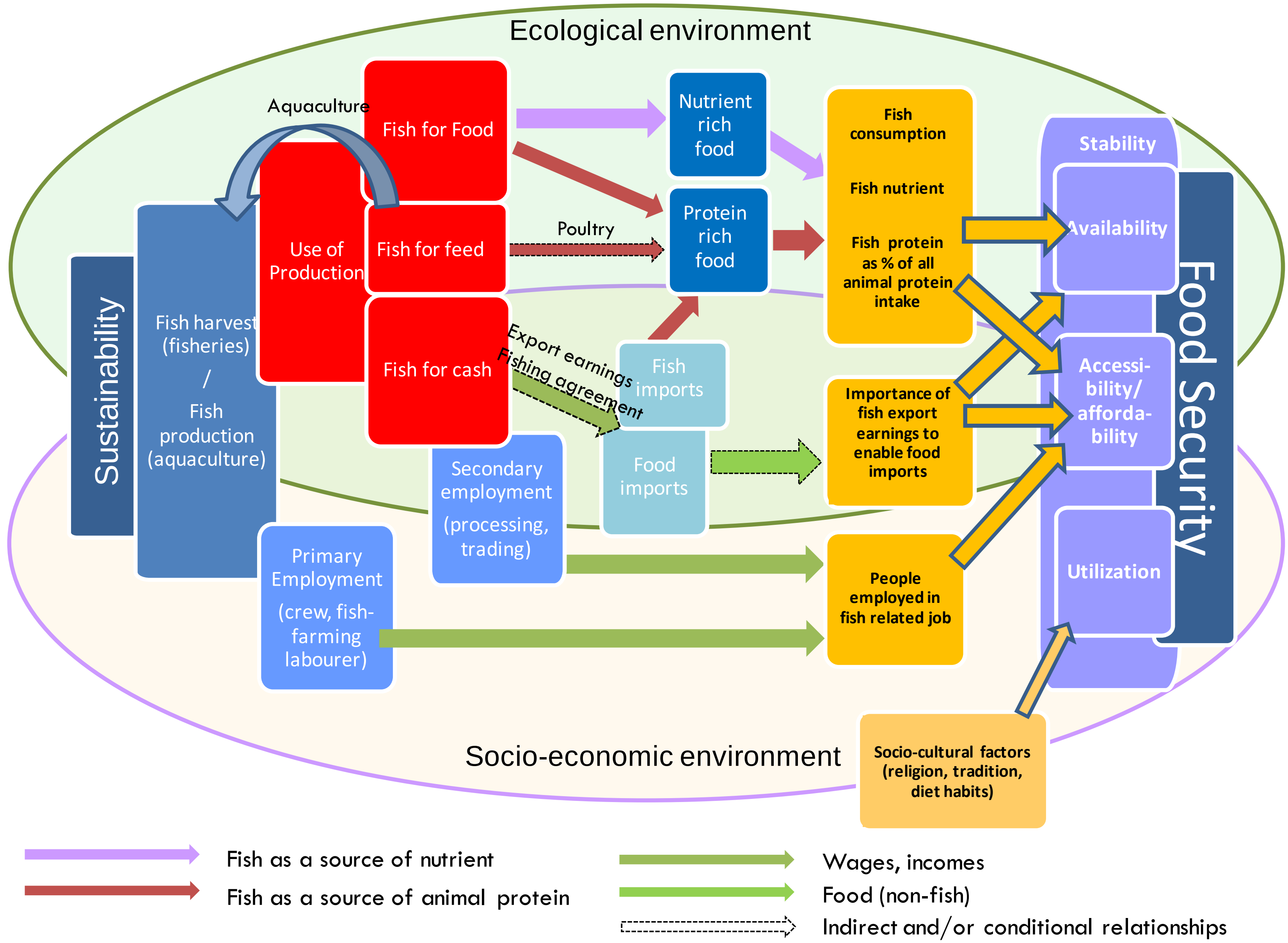


Figure 3.1. Conceptual representation of the different pathways between fish and food security and nutrition

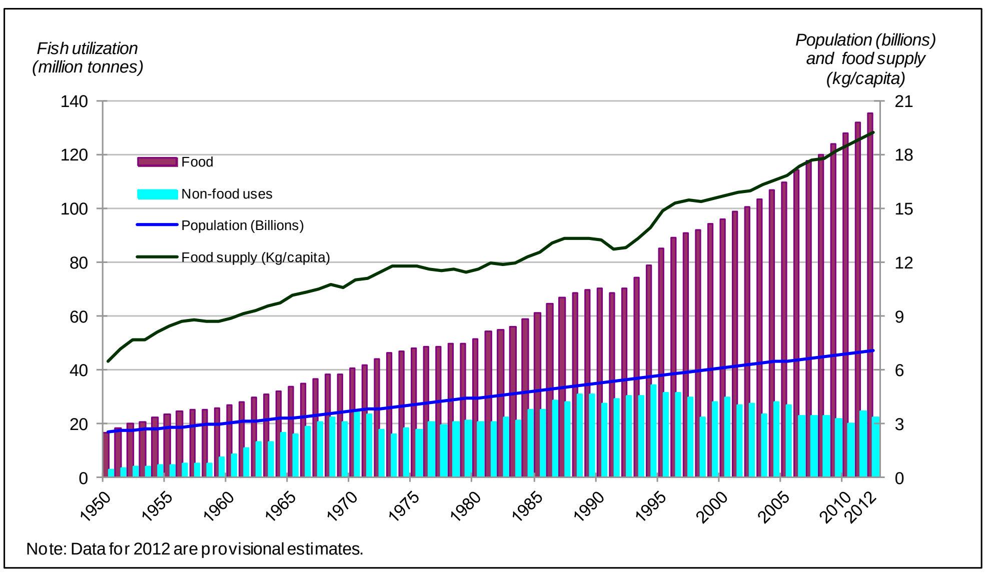
Source: Scholtens and Badjeck (2010) and authors.

We present below the current consensus as found in the literature about these three functions, while controversies and debates and how aspects of these debates relate to food security, are discussed in greater details in the following chapters.

Fish for food

As a food commodity, fish can be processed into a wide array of products. It is generally distributed as live, fresh, chilled, frozen, heat-treated, fermented, dried, smoked, salted, pickled, boiled, fried, freeze-dried, minced, powdered or canned, or as a combination of two or more of these forms. As such, fish contributes to the food security and nutrition of both producers and rural and urban consumers throughout the world. Capture fisheries and aquaculture supplied the world population with about 156 million tonnes of fish in 2011, of which about 131 million tonnes was utilized as food for people. With sustained growth in fish production and improved distribution channels, world fish food supply has almost tripled since 1950, passing from 6kg/capita/year to 18kg/capita/year in 2010. In fact, with an average growth rate of 3.2 percent per year in the period 1961–2009, the world fish supply has effectively been growing faster than the world's population (Fig.3.2).

Fig.3.2 World fish utilization and supply



Source FAO 2012

These global figures, however, mask regional variations, which result from less or non-efficient local market channels but also reflect differences in cultures, beliefs, diet habits, and purchasing powers of the populations, which strongly influence the consumption levels (Box 3.1). Overall at these regional levels, fish consumption is lowest in Africa (9.1 million tonnes, with 9.1 kg per capita in 2009), while Asia accounts for broadly two-thirds of total consumption, with 85.4 million tonnes (20.7 kg per capita)[4].

[4] All the figures and data are extracted from FAO data base.

At the same time per capita fish consumption estimates for Oceania, North America, Europe, and Latin America and the Caribbean are 24.6 kg, 24.1 kg, 22.0 kg and 9.9 kg (for 2009), respectively (Fig.3.3). Finally, it is also important to notice that although annual per capita consumption of fishery products has grown steadily in developing regions (from 5.2 kg in 1961 to 17.0 kg in 2009) and in low-income food-deficit countries (LIFDCs, from 4.9 kg in 1961 to 10.1 kg in 2009), it is still considerably lower than in more developed regions.

Yet in many of these LIFDCs, fish is a major source of animal protein (Reynols 1993; Béné et al. 2007; FAO 2012; Allison et al. 2013) and as such is often presented as a key element of food security for the poor (e.g. Kent 1997, Belton et al. 2011). Among the thirty countries in the world where fish contributes more than one-third of the total animal protein supply (Fig. 3.4a), twenty-two are officially referred to as low-income food-deficient countries (LIFDCs) (Karawazuka and Béné 2011). In other words, almost three quarters of the countries where fish is an important source of animal protein are poor and food deficient.

Box 3.1Synthesis of observations on geographical, rural-urban and income-group differences in fish consumption patterns in selected developing regions and countries. (Source: Allison et al. 2013 Box 4 p.40)

Lake Victoria

Households in Nyanza province on the Lake Victoria shore of Kenya spent 6.1% of their food budget on fish, compared to the national average of 2.1% (Grab, 2009). According to a World Food Program study cited in Finegold (2011) fish in Uganda “is relatively more important than meat in the diet of the poor” in terms of numbers of days of fish and meat consumed. The study also shows that among the different income quartiles, the absolute level of fish consumption is almost the same, but the higher quartiles consume more of the other animal source foods (meat, milk, chicken, eggs).

In all three countries sharing Lake Victoria, the poor consume small fish (dagaa/mukene/omena) which also has a market as chicken feed, potentially threatening food security (Te Lintelo, 2008); tilapia is consumed by the urban middle-class and Nile perch is exported (Finegold, 2011; Kabahenda,2009).

Namibia

Highest nutrition and livelihood dependence on fish is in the Caprivi strip, on the border with Angola, and this is from inland fisheries: “if you don’t fish, you are not a Caprivian” (Tvedten, 2002). Reliance on wild foods (including fish) is also highest in this region (Mulonga, 2003). Namibia’s important marine fisheries are export-orientated and industrial and of little direct importance for livelihoods and nutrition to the countries’ population. Poorer consumers in the Caprivi prefer catfish as it is cheaper whereas higher income groups purchase bream and redbreast tilapia (Purvis, 2002)

Solomon Islands

Per capita expenditure on fish in Honiara (the capital), Central and Rennell-Bellona is 2-3 times greater than in Temotu Makira-Ulawa and Malaita Provinces. The latter also showed the highest poverty rates in Solomon Islands (UNDP 2008). Approximately 75 percent of fish consumed in Choiseul, Isabel and Central Provinces is obtained from subsistence fishing, while in Honiara and Guadalcanal Provinces, 90 percent and 51 percent of fish respectively are purchased (HIES 2005/06, Weeratunge et al 2011)

Fish (both caught and purchased) comprises around 20 percent of the total expenditure on food in poorer households in Honiara and other urban areas, and 14 percent of total expenditure in similar status households in the rural areas (UNDP 2008).

Bangladesh

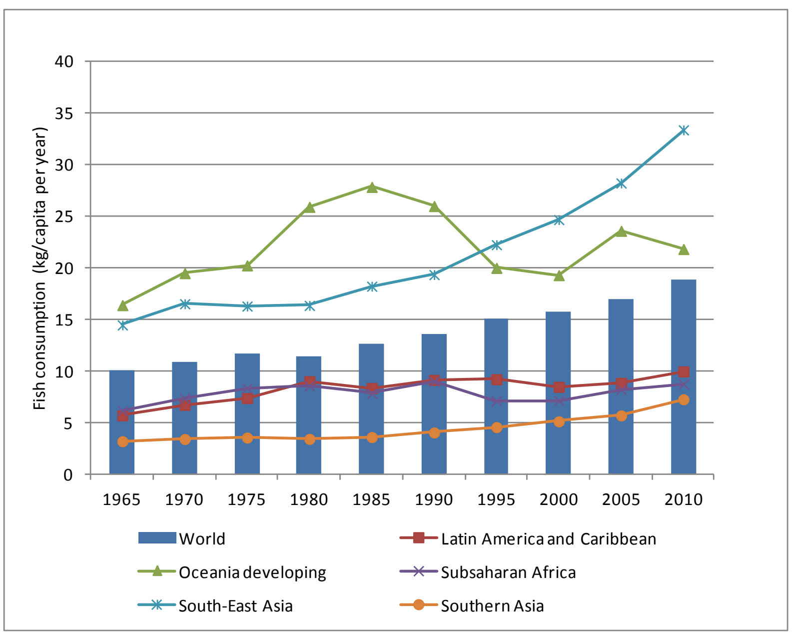
Little difference in fish consumption between rural and urban populations in terms of intake and expenditures, but literature on urban populations showed contrasting patterns: species diversity was greater in the diets of villagers in Bangladesh, while slum dwellers consumed low quality, cheap fish and a great amount of dried and fermented fish (Hossein et al 2009).

Fish per capita intake in Bangladesh is almost double for the non-poor group compared to the poor group (57.8g/capita/day and 31.2g/capita/day, respectively). Fish remains the largest item of expenditure on animal source foods (ASF) for each income quintile of the population but there is a significant increase in expenditures on fish between the lowest and highest quintile (Thorne-Lyman et al, 2010, Anwarul and Arshad, 2010). Major Indian carps command high prices and are therefore preferred by high income consumers (Alam, 2002). The poor eat mostly exotic (farmed) carps such as silver carp and the Mekong river catfish (*Pangasius*) as these are cheap (Alam, 2002; Hossein et al, 2009).

The references cited in the box need to be entered in our reference list

When other sources of protein (i.e. plant) are considered however, the contribution of fish to total protein consumption appears to be substantially lower (Fig. 3.4b), indicating that in fact in LIFDCs the majority of protein still comes from plant-sourced foods. Plant protein however lacks some of the essential amino-acids, which then may cause nutrition related illness.

Fig.3.3. Regional difference in fish consumption



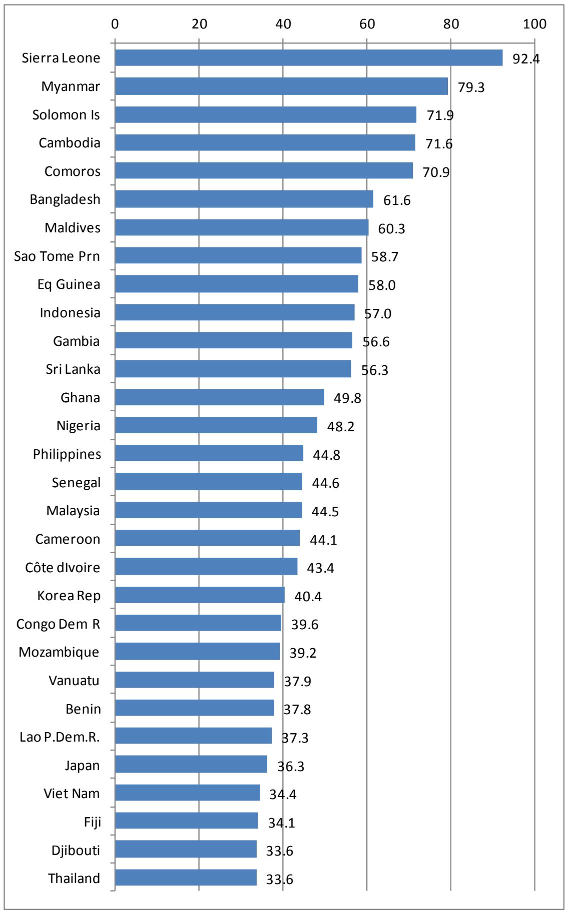


Fig.3.4(a) Fish as a percentage of animal protein consumption

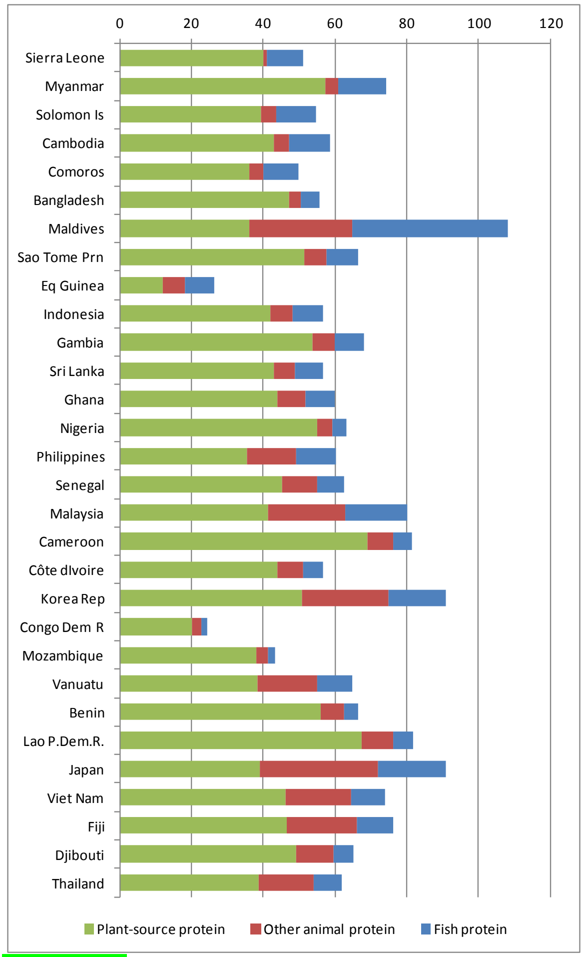


Fig.3.4(b) Total protein consumption in g/capita per day

Source: updated from Karawazuka and Béné (2011).

Fish for feed

The second distinct way fish is used at a global scale is as a source of animal protein (fishmeal) for poultry / livestock and aquaculture (Tacon and Metian 2009, Fig.3.1), and pet food (de Silva and Turchini 2008). In 2010, 20.2 million tonnes of fish -essentially small pelagic forage fish species such as anchovies, herring, mackerel, or sardines- were still destined to non-direct human food use, of which 75% (15 million tonnes)[5] was reduced to fishmeal and fish oil to feed carnivorous farmed fish and crustaceans species (salmon, trout, tuna, or shrimp) as well as poultry and other livestock. Thus, in 2010, 56% of the total world fishmeal was use to feed farmed fish, followed by pigs (20%), poultry (12%) and others (12%) (Table 3.3).

[5] The remaining 5.1 million tonnes was largely utilized as fish for ornamental purposes, for culture (fingerlings, fry, etc.), for bait, for pharmaceutical uses as well as raw material for direct feeding in aquaculture, for livestock and for fur animals (FAO 2012).

Table 3.3 Percentage of world fishmeal market use by sector.

	2002	2007	2008	2010
Ruminants	1	-	-	<1
Pigs	24	24	31	20
Poultry	22	7	9	12
Fish	46	65	59	56
Others	7	4	1	12

Source: Fishmeal information Network (cited in Hall et al. 2012).

The dependence of farmed fish (and livestock) on fishmeal raises some important questions with regard to food security. In particular, is fishmeal the most efficient way to use fish (especially, cheap small pelagic fish rich in omega-3 fatty acids like those which are currently used for the production of fishmeal) or would these fish have a greater impact in terms of food security if they were made available for local consumers in the countries where they are caught? These questions will be explored more thoroughly in section 3.7.

Fish for cash

The third main use of fish derives from its 'cash crop' function (Béné et al. 2009). Today, and likely historically, very few small-scale fishers and fish-farmers consume the totality of their production. Instead, responding to a (growing) need for cash, these small-scale operators sell (an increasing) share of their catch. Likewise, larger, more commercial-oriented fleets and aquaculture enterprises usually sell the totality of their productions. Through these trading activities, these different types of operators generate direct revenues and primary employment (fishing crew, pond labourers), as well as secondary employment (formal and informal fish traders, fish processing plant workers, etc.). It is estimated that between 660 and 820 million people (workers and dependents) depend totally or partly on fisheries, aquaculture and related industries as a source of incomes and support (Allison et al. 2013).

The important point is that the vast majority of these people live in developing countries, and are not always well integrated in the more formal economy and society. For these people fisheries and aquaculture activities are therefore a critical source of cash and several empirical studies have confirmed the central role of that cash-crop function (Neiland et al. 1997). A recent study based on data collected from chronically poor fisher-farmers[6] in Democratic Republic of Congo shows for instance that the poorer the people in these communities the more they depend on fishing activities for their income (Fig.3.5). In theory the link to food security is straightforward: because they contribute a significant share of a household's cash income, revenues derived from

[6] Fishers-farmers are rural households who engage in both fishing and farming (and possibly other non-farming activities) and alternate these two main activities in the course of the year. They are in fact the vast majority of these who are not professional fishers, in other words, the larger group of fishing households in the world.

fishing and fish-farming act directly on the FSN of these households by strengthening their purchasing power and improving their accessibility to food. In theory cash income also facilitates access to higher quality food, and to better health and sanitation conditions. As such, incomes derived from fisheries and aquaculture activities should impact positively on the utilization dimension of food security. In practice, if the profit from fish is not sufficient, then people will still remain poor.

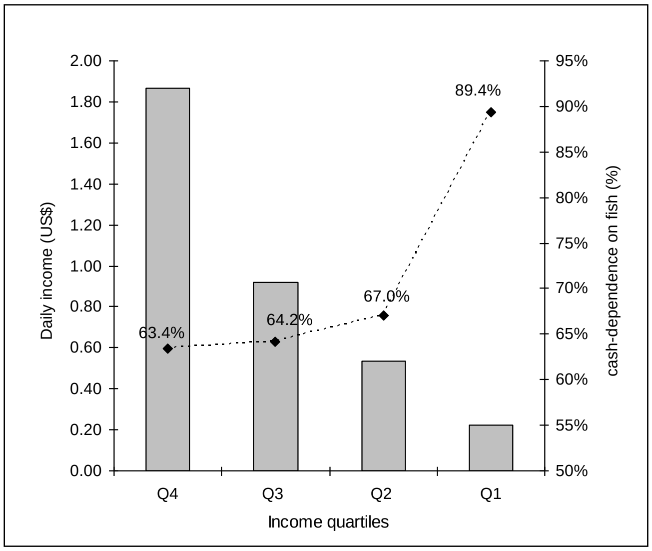


Fig.3.5. Relative contribution of cash generated by fishing activities to household aggregated income – households ranked by quartile, from the poorest (Q1) to the richest (Q4) (Source: Béné et al. 2009)

The degrees to which these links operate in reality and the question of whether or not fish revenues are sufficient and/or effectively used to secure access to (non-fish) high quality food are unclear. The evidence documenting the ways fishing and fish-farming households use their income remains scarce in the literature and does not generally provide any counterfactual. The pathways 'fish revenues → food purchase → food security and nutrition' at the household level remains, therefore, largely unquantified. To our knowledge the only exception to this lack of rigorously demonstrated link between fish and food security and nutrition is Aiga et al. (2010).

Beyond the household level, fish trade is also recognized to contribute to food security at the macro, country-level, essentially through the generation of revenues from exports, taxation, license fees and from payment for access to resources by foreign fleets or foreign investment in aquaculture (Valdimarsson & James; Bostock et al. 2004; World Bank, 2004; FAO, 2007). Representing about 10% of total exports of agricultural products by value, seafood exports from wild fisheries and aquaculture in 2008 had a combined value of US$102 billion (FAO, 2010), an 83% increase from 2000. The share of exports from developing countries is close to 50% by value and 60% by volume. Of internationally traded agricultural commodities seafood export value is exceeded only by fruits and vegetables (Fig.3.6).

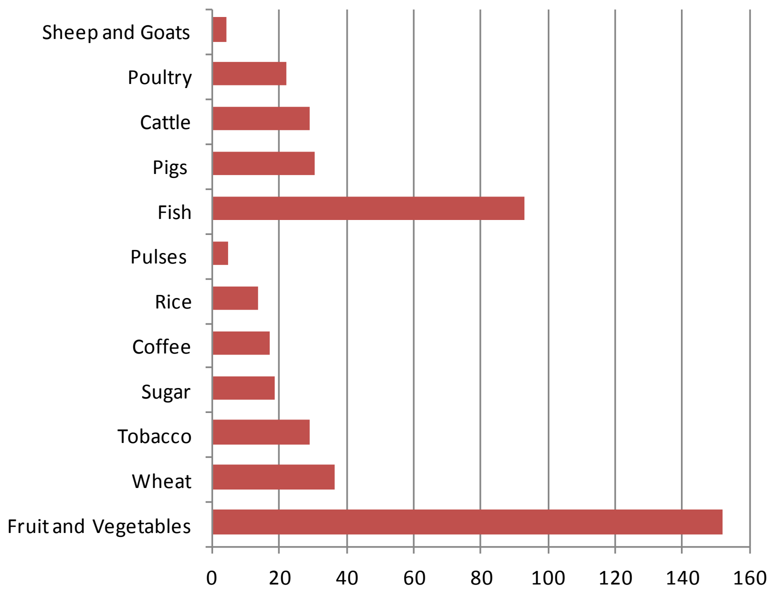


Fig. 3.6. The export value of selected agricultural commodities in 2007 (in US$ billion). Source: FAOStat and FAO TradeStat 2007

Net exports of fish and fish products (i.e. the total value of fish exports less the total value of fish imports) are particularly high for developing countries. They have grown significantly in recent decades, rising from US$3.7 billion in 1980 to US$18.3 billion in 2000, and reaching US$27.7 billion in 2010. For LIFDCs, net export revenues amounted to US$4.7 billion in 2010, compared with US$2.0 billion in 1990. However, as for households, what these figures only suggest is that fish can generate large amounts of revenues at national level. Whether these revenues are effectively used to import other non-fish (or affordable fish) food commodities and thus contribute to food security and nutrition is not clear. This question of the impacts of fish trade on food security (does fish trade improve food security? If so, of who, who are the winners/losers of international fish trade?) will be explored more thoroughly in section 3.6).

3.4 Resource and environmental sustainability: necessary but not-sufficient conditions for food security

The potential for fish to contribute to food and nutritional security depends partly on the quantity and types of fish produced and the environmental sustainability of the natural and farm ecosystems that support production, but also on numerous distributional and access factors.

When the environment, production ecosystems and/or the resources-bases (fish stocks) are degraded or over-exploited, the abilities of the sectors to deliver their FSN functions are limited or reduced (Agardy and Alder 2007; FAO/NACA 2012). Production losses from unsustainable over-exploitation were one cause of the estimated annual loss of $50 billion from capture fisheries (World Bank and FAO 2009). On the surface, the environmental sustainability of both fisheries and aquaculture is recognized to be a sine qua none condition for FSN. In practice, the links are more complex.

In the case of fisheries, Srinivasan et al. (2010) calculated the number of people in food-deficit countries for whom sustainable fishing might have alleviated hunger – assuming access by the poor. The authors estimated the catch losses induced by overfishing and converted them into potential food energy. Assuming an energy content of 120 kcal per 100g of marine landings, they found that 20 million people could avoid under-nourishment annually if fisheries were not over-exploited. Although the calculations are subject to debate and do not address the allocation and access issues, the study captures the point that over-exploited or degraded resources create an absolute loss of potential product that could be used for FSN by producers and/or consumers.

To the knowledge of the authors of the present report, similar estimates of the consequences of unsustainable production have not been attempted for aquaculture. Such estimates, however, could be more complex because more options for innovation such as new culture species (Lebel, et al 2010) and trade-offs with other uses of the environment would be available compared to fisheries ecosystems. During the 1990s and 2000s, several studies emphasised the likely link between the degradation of the environment induced by the rapid development of the sector and the FSN of people – often fishers - living in the surrounding areas. For example, in El Oro province (Ecuador), total aquatic production, losses from shrimp diseases and environmental degradation have waxed and waned along with the struggles between shrimp farmers, women and men cockle gatherers and those supporting mangrove conservation (Beitl 2012). Beyond this specific local example, although the actual impact of these environmental degradations on the FSN status of local populations has never been rigorously quantified, there is little doubt that the increase in soil and ground water salinity induced by the development of shrimp farming in Bangladesh or in Thailand (Flaherty et al. 1999), or the destruction of mangrove in those same countries and other part of Asia or Latin America caused by the expansion of the aquaculture industry (Gujja and Finger-Stich, 1996; Cruz-Torres 2000) have had detrimental consequences on the food security of the local populations7.

Recognizing that the links between FSN and sustainable production are context-specific, complex and often speculative, in this section we proceed on the basis of the logical consensus that unsustainable uses of the resource-base (over-exploitation, losses from

[7] Some would however argue (correctly) that this negative externality needs to be considered in relation to the revenues (both at local and national levels) that are generated by the aquaculture sector.

diseases and/or environmental degradation induced by fish-farming) will have immediate and often also long term negative effects on FSN, either directly or indirectly. In particular, ecologically unsustainable fishing and/or fish-farming activities have direct impacts on two dimensions of food security: availability and accessibility.

At the same time, fish as food cannot be considered in isolation from other food commodities, as it only produces approximately 1% percent of the total calorie intake of humans. Shortfalls in fish production might be compensated by that from other foods (or vice versa). However, all other foods also face challenges in their future production and demand (Godfray et al. 2010; FAO 2013). The precautionary assumption is that the world needs to simultaneously secure the sustained long term production of all food types to meet its growing demand, rather than expect that losses in any major commodity will readily be compensated by another.

Changing modes and geography of fish production

Over the last three decades, fish production for direct human consumption has experienced a major shift from the dominance of capture fisheries to, presently, equal production from aquaculture and capture fisheries. Aquaculture production is expected to continue to increase, although it will continue to meet challenges, but the outlook for capture fisheries is not as certain.

Capture fisheries production has been on a plateau since the early 1990s. The causes of the plateau have been the source of considerable scientific analysis, debate and a significant level of agreement among experts. In the present section, we summarize the main results of this. Overall, these dynamics are described mainly in biological terms in fisheries status reports (e.g., biennial FAO Status of Fisheries and Aquaculture reports) but they could bear closer scrutiny under a FSN lens.

At times, the high rate of increase in aquaculture production has been tempered by setbacks such as viral disease outbreaks that devastated shrimp farming in several locations (Briggs et al. 2004). Increasingly, however, aquaculture is developing and applying technological approaches and better management to achieve more efficient and sustainable resource use (Costa-Pierce et al. 2012).

The geography of fish production has also changed in recent decades. Geography is a factor in food security as it has some impact on who has access to capturing, farming and buying the fish and how. Developed countries dominated production until 1986 and developing countries, led by those in Asia, led thereafter (Williams 1996). The lead continues to increase. This geographic trend was a result of the plateau (North America) and decline of capture fisheries production in developed countries, especially in Europe, and the rise in Asia of aquaculture and to a lesser extent capture fisheries production (Williams 2008). Fish is geographically redistributed through trade and foreign fisheries access agreements. Developed countries made up for their reduced production by importing fish from developed countries, although significant trade also occurs among developing countries.

Fisheries Crisis

A global science, media and NGO discourse, particularly but not only in the developed countries, frequently proclaims the crisis in wild fish populations and therefore for their production and potential to support FSN. Although these debates may mention food security, and occasionally nutrition, in effect they are biological debates, relying on biological fish assessment methods (See Box 3.2) and framed primarily around assumptions of maximizing the economic value of the fisheries stocks, such as by favouring fish of larger sizes and of higher value species. As a generalization, fish for FSN tend to be smaller and of lower value. In industrial fisheries stock assessment, many of these species are considered primarily for their fish meal value and not their food value, or are regarded as “forage fish” for larger fish, birds and mammals in the ecosystem (Pikitch et al 2012).

Since the fisheries crisis debate began in the early 1990s, fisheries conservation has been on the campaign agendas of environmental NGOs. The “world fisheries crisis” is reasonably well founded, although some of the key scientific papers on which it is based are fraught with simplifications, contain methodological errors and notable data gaps especially for developing country fisheries. In the main, the key scientific papers have been published by scientists in academe seeking global conclusions, and the challenge have come from government and inter-government organization scientists seeking to correct the methods, inappropriate use of some data and to place more accurate results on record. Moreover, they also come to conclusions of considerable overfishing, but with greater caution on interpreting the data and nuance at to where and to what extent the resources are being unsustainably used (Table 3.4).

Table 3.4 Views and counter-views in the fisheries crisis debate

Fisheries crisis views	Counters views
• 90% of large, predatory fish have gone (Myers and Worm 2003)	• Inappropriate data and analytical methods have been used • Tuna stocks (except for Bluefin tunas) not depleted to this extent (Polachek 2006, Sibert et al 2006)
• Commercially fishing will end by 2048 at present rate of stock collapses (Worm et al 2006) • Appropriate analyses of data-poor fisheries shows that the patterns of resource status are similar to those for more data-rich fisheries (Costello et al 2012)	• Yes, fisheries do collapse, but they tend to rebuild at about the same rate (Branch et al 2009) • Many fish stocks do not have data suitable for use in these analyses, especially for small scale fisheries • Outlook for marine fisheries is mixed, with positive and negative prognoses, depending on the stocks (Worm et al 2009)
• At global aggregate, the trophic level of landed fish is declining (“fishing down the food web”) (Pauly et al 2006)	• “Fishing down” is not ubiquitous at regional scale, e.g., in large marine ecosystems. However, fishing is taking more and more of the aquatic resources –

	fishing through/down/up food webs (Essington et al 2006, Branch et al 2010)

Implicitly, much of the scientific debate had concerned the effects of selective fishing - the harvest of fish species and sizes out of proportion to their occurrence in the ecosystem (Garcia et al 2012). With models and fisheries data, Garcia et al (2011) explored the problems of selective fishing and predicted that a "balanced harvest" across species and size ranges of each species in relation to their natural productivity would result in greater sustainability of production at a higher level of harvest. However, if the total level of harvest is too high, even with balanced harvests, stock will collapse eventually.

The concept of "balanced harvest" is generating debate within the fisheries assessment, marine resource conservation and small-scale fisheries science communities. Balanced harvest may be closer to the pattern of exploitation in small-scale fisheries where food security of the participants is the objective. This has led some experts working with broader interests than environmental sustainability and economic yield to start to develop a new counter-view on the fisheries crisis from that of the academic and governmental fisheries scientists (e.g. Kolding and Zweiten 2011, Garcia et al 2012; Kolding et al. 2013, Law, et al. 2013). In these early stages, however, their views have been piecemeal and do not necessarily provide a unified alternative to the "fisheries crisis" headlines. Instead, they urge for greater caution on interpreting the data and nuance as to where and to what extent the resources are being unsustainably used, and for what purpose.

Box 3.2. The Historical Purpose of Fish Stock Assessments

For over a century, fish stock assessment science has been the lead field of fisheries science and its practitioners have interfaced with the human dimension of fisheries through fisheries management agencies and the fishing industry (Smith 1994). Management has tended to focus on maximizing the quantity and value of catches, economic growth of the sector and stock sustainability under these conditions rather than maximizing livelihoods, food and nutrition security. In his excellent summary for FAO of the development of fish stock assessment, Saetersdal (1992) cautioned, however, that "other national objectives – such as equitable distribution of resources, value added processing, labour, foreign exchange earnings – may be deemed more important for national economies." Regardless, stock assessment models typically do not advise on distribution objectives such as food security and the management of fish species most important to FSN. Stock assessment and related management methods, however, could have many tools with which to undertake such work and this could provide a very rich field of endeavour for the analysts. To be effective, it would need to be embedded in the appropriate governance and management frameworks for recommending how to achieve FSN outcomes.

However, regardless of the patterns of exploitation, the inescapable fact is that wild fisheries resources are under heavy and increasing pressure and many are over-exploited and need to be rebuilt to make a better contribution to production, and likely FSN. Much remains to be done to interpret fisheries resource sustainability in terms of FSN rather than standard fisheries management objective such as maximum sustainable and maximum economic yield.

Aquaculture Environment Impact

Environmentally sustainable aquaculture production depends on the right combination of farming systems (including health management), feeds (See section 3.7) and improved germplasm (Browdy et al. 2012).

As aquaculture is still a relatively new industry, its recent development has entailed major changes in land and water body use. The ecological conversions to introduce aquaculture have often disturbed existing uses and users, and some have been ecologically damaging. The conversion of large areas of land and wetlands to fish and shrimp farms, and of coastal, lake and river habitat to cage, raft and stake culture has had major environmental impacts such as loss of biodiversity, introduction of alien species, pathogens and parasites, pollution from farm and farm chemical wastes, increases in soil and ground water salinity and the loss of ecosystem functions (Barraclough and Finger-Stick 1996; EC 1999; EJF 2002). For example, aquaculture is estimated to have led to the additional destruction of 10% of mangrove areas, over and above destruction from other land uses (World Bank 2006) and have had detrimental consequences on the food security of the local populations[8].

The environmental impacts of aquaculture have led to criticism, e.g., Naylor et al (1998), Naylor et al (2000). They have also stimulated anti-aquaculture environmental campaigns, and social justice campaigns when livelihood and living space of small-scale fishers are affected. The campaigns have been primarily in regard to shrimp and salmon farming and more intensive industrial aquaculture (de Silva and Davy 2009). Aquaculturists are now more confident that the era of severe environmental problems is behind and that aquaculture is on the road of sustainability (Costa-Pierce et al. 2012). Aquaculture has also become a more accepted form of fish production as people, especially in developing countries, have become more and more dependent on aquaculture fish. However, as in fisheries, the debate on the sustainability of aquaculture has only occasionally been framed in relation to food (or nutritional) security.

Domestication that allows genetic improvement stock in aquaculture is and will be a major driver of efficiency of production and thus opportunity of lowering the ecological footprint. Although estimates of the extent of domestication and use of genetically improved stocks are difficult to make (Benzie et al 2012), one study estimates that

[8] Some would however argue (correctly) that this negative externality needs to be considered in relation to the revenues (both at local and national levels) that are generated by the aquaculture sector.

about 20% of cultured species are domesticated and that the percent of domesticated species increases with the total production (Bilio 2008). However, in the absence of effective genetic improvement and breeding programs cultured stocks may even be inferior to wild populations due to inbreeding (Acosta and Gupta, 2010). The whole process of species selection and breed improvement starts with choosing species to grow and domesticate, keeping markets and end users in mind. From an environmental viewpoint, genetic improvement offers great opportunities but also some risks. It requires that natural biodiversity is conserved, at the ecosystem, species and genetic level. At present, the Commission on Genetic Resources for Food and Agriculture is undertaking the first State of the World's Aquatic Genetic Resources report[9]. Future aquaculture development will likely concentrate on fewer species than at present, but we do not foresee the same degree of concentration that occurs in terrestrial animal and crop production, due to the wide variety of aquatic ecosystems and the lower ability to entrain or transform these totally for human use.

Bilio (2008) and Browdy et al (2012) recognize the great benefits of domestication and genetic improvement, but also warn of the risks if breeding and germplasm conservation programs lead to too narrow a genetic base. Respecting the differences between taxa in the aquatic, crop and animal terrestrial realms, agriculture and animal husbandry can make large contributions to aquaculture genetic improvement.

As with many other aspects of sustainability, FSN has been only one factor in germplasm conservation and genetic improvement programs. The GIFT tilapia program commenced as a food security initiative and has made enormous contributions because of the choice of species (Gupta and Acosta 2004), but tilapia is now a major trade commodity and commercial interests, in addition to FSN, is a major driver of breed development.

The extent to which new molecular genetic technologies contribute to increasing and improving aquaculture production sustainably will depend on strong scientific consortia (Browdy et al 2012). Only research partners with explicit mandates or interests in FSN can help ensure that the benefits of the new (and existing) genetic improvement technologies are directed to FSN objectives through the species and breeding traits selected and through partnerships for dissemination. These factors are what has made the CGIAR system so relevant in crop and livestock breeding for the developing world.

3.5 Food security at the producer level: trade-off between self-consumption and income [10]

Fisheries is said to contribute to food security, directly through self-consumption, and indirectly through income generation. This narrative is broadly true but as this section

[9] http://www.fao.org/nr/cgrfa/cthemes/aqua/en/

[10] This section relies heavily on Karawazuka and Béné (2010).

will show, it is also over-simplistic. The question of self-consumption versus income generation is in fact one of these ‘prisms’ mentioned in the introduction, which help in highlighting some of the complexities that characterize the situation. Many questions call for more attention and in-depth understanding: do poor people benefit more (from a food security perspective) from self-consumption than from selling part of their catch -, or are there cases where (poor) fishers jeopardize their nutritional security (by selling more of their own catch) in order to improve their food security? Are fishing communities more food-secure than their counterparts (e.g. small farmers)? The contribution of fish to food security is also too often reduced to the share of fish to total animal protein, thus neglecting other aspects of its nutritional contribution, including long-term brain and physical development potential. In this section we will revisit and present the current state-of-knowledge related to some of these questions. As it will become rapidly clear, many of these questions are still insufficiently documented.

Direct contribution (self-consumption)

Fisheries

Approximately half of fish catches at global level originate from small-scale fisheries. When catches destined to direct human consumption are considered, the share contributed by small-scale fisheries increases to two-thirds. Yet, at the household level, the contribution of small-scale fisheries (and in particular inland fisheries) to rural household consumption is often under–estimated, as catches from subsistence fishing are rarely included in national catch statistics and their contribution to these households is often ignored (Ahmed et al., 1996; Dey et al., 2005; Béné and Friend 2010). A consequence of this systematic lack of data is that one has often to rely on case-studies to assess or document the contribution of small-scale fisheries to FNS.

All these case studies confirm that in many settings in developing countries fish from small-scale fisheries represents one, if not the principal animal source food for the population, supplying both high quality protein and essential micro-nutrients for maintaining health and well-being (Kawarazuka and Béné, 2011). Yet large differences are observed in the level of fish self-consumption. In Lao PDR for instance, Garaway (2005) estimated that in the communities where she worked about 75% of the fish were consumed at home. In contrast in Papua New Guinea, Friedman et al. (2008) found that only 11– 20% of the total catch of fin fish caught by households were kept for home consumption. More generally, in areas where fish are abundant year-round, people seem to consume fish caught by household members and hardly buy them in the markets (Neiland et al. 2000; Pinca et al. 2008).

The literature also revealed that the species consumed at home are often low market-value fish, but other aquatic animals are also consumed. In Laos and Cambodia for instance, frogs, freshwater molluscs and snails are frequently included in the daily diet of the poor (Meusch et al. 2003; Chamnan et al. 2009). Even households which farm fish in ponds usually engage in small-scale fishing activities during the peak fishing season in order to catch and consume small fish at home (Roos 2001; Thompson et al. 2006; Karim 2006).

Women in food insecure households also tend to engage in fishing for household consumption (e.g. Merten 2004), and anecdotic data from fishing communities in Congo suggest that the fish caught by women are usually small and that a greater proportion of them are kept for home consumption (Fig.3.7). While no detailed nutritional analysis was performed in that case, it is likely that this combination of small fish and the high proportion of self-consumption may have important implications for nutritional security. In particular it suggests that although almost marginal in terms of quantity women-fishing may play a disproportional role in the nutritional security of the household members (Béné et al. 2009).

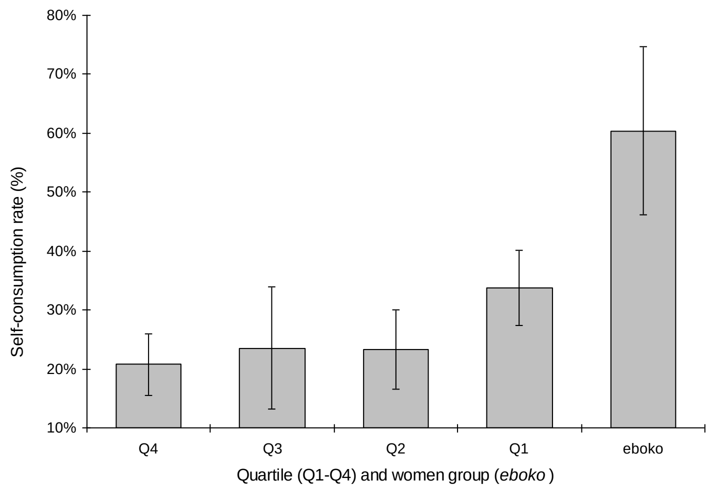


Fig.3.7. Rate of fish self-consumption for income quartiles (Q1-Q4) and for the fish caught by women (eboko). Q1 = lowest quartile; Q4 = highest quartile, in a fishing community in Democratic Republic of Congo. (Source: Béné et al. 2009)

In most of these studies, however, no counterfactuals are available that would enable us to compare fish consumption between fishing households and non-fishing households. The only exception is the study by Gomna and Rana (2007), in which these authors compared the relative importance of fish and meat between 50 fishing households and 50 non-fishing households (agriculture being stated as the primary activity) in the coastal state of Lagos and the inland state of Niger in Nigeria. Their data show that, at the household level, the consumption of fish in fishing households was twice that of non-fishing households, whereas levels of meat consumption were similar.

Fish-farming

As in the case of small-scale capture fisheries, more than 80% of global aquaculture production may be contributed by small-scale fish farmers, nearly 90% of whom live in Asia. And as for the fishing households, these farmed fish are expected to contribute to improved nutritional status of households directly through consumption of fish produced from households' own ponds, and indirectly by selling fish for cash to enhance fish-farmers' purchasing power (Ahmed and Lorica, 2002; Dey *et al.,* 2006; Jahan *et al*., 2009). The evidence however is not conclusive. In particular many, but not all, of these studies report an increase in household fish consumption for those who invest in pond-based aquaculture or in integrated agriculture-aquaculture (IAA) systems (Prein and Ahmed 2000). In India, Kumar and Dey (2006) observed that the energy intake of households that own fish ponds was 10.9% higher than that of households with wage earners but without ponds, and that the undernourished population amongst the fish pond owners was 10% lower than that for the control population[11]. In the Dinajpur district of Bangladesh, another survey showed that small fish species are important food items for low income households with fish ponds, especially in months when vegetables are not available or not affordable (Islam 2007). In Malawi, Dey et al (2006) compared fish consumption between households with and without fish ponds. They observed that the frequency of fresh fish and dried fish consumption is higher in households with fish ponds.

Yet, in other cases, households with fish ponds do not necessarily show any increase in their fish consumption. When they compared a group of households participating in a fish pond polyculture project in the Kishoreganji district of Bangladesh, Thompson and his co-authors (2002, p.297) found no significant difference in fish consumption between producing and non-producing households. In fact, 32% of the households from this survey never consumed the fish they produced. Another survey in Bangladesh suggests that fish produced through homestead aquaculture contributed only 1–11% of the total amount of fish consumed at household level and that fish from wild fisheries bought from local markets were the single most important source of fish consumed locally (57–69%, depending on season) for both households with and without fish ponds (Roos 2001).

One reasons for the apparent failure of aquaculture to improve household direct fish consumption is that fish produced by aquaculture usually differ from fish supplied by common-pool resources in their species or varieties, and in the objectives they serve (Prein and Ahmed 2000). Much aquaculture production (even at small-scale) is orientated towards producing medium or large size fish for high value markets. Aquaculture fish are, in fact, often considered as a 'cash crop', rather than a 'food crop'. Furthermore, the cash generated through aquaculture is rarely used to purchase smaller fish for home consumption. For instance, the same study which showed that the majority of fish consumed in Bangladesh are wild and purchased in local markets also found that expenditure on purchasing fish does not show a significant difference between households with fish ponds (47 taka per capita/month3) and without fish ponds (55 taka per capita/month) (Roos 2001).

[11] These authors do not indicate, however, whether those differences were statistically significant

Indirect contribution (cash)

Increasing purchasing power through the sale of fish is in theory the main indirect pathway to improve overall dietary intake of fishers (Karawazuka and Béné 2010). In that regards it is well established that fishing and fish trading can be the source of important cash revenues. In fact, contrary to the persistent narrative that describes fishers as being amongst the 'poorest of the poor', the reality is often more complex and more nuanced. While there is no doubt that fishers living in isolated or remote areas face extremely severe living conditions, several empirical studies suggest that in other circumstance fishers can also be relatively well-off, thanks to the cash they derived from their fishing activities (e.g. Panayotou 1985; Neiland et al. 2005, Béné et al. 2009). Even when fishing is not the primary source of income, it can still be key in relation to (indirect) food security (cf. Box 3.3).

Box 3.3. Fishing as a secondary –yet critical- source of income

A study in the Kompong Thom Province of Cambodia detailed the importance of small-scale fisheries as a secondary source of income (Hori et al. 2006). During the dry season, some of the villagers move to the Tonle Sap Lake, located 30 km away from the study villages, and sell most of their catches for cash, while others only fish (mainly for subsistence) in rice fields, ponds, and streams surrounding the villages. The income derived from fishing in the lake contributes to the annual household income, which Hori estimated was approximately double that of the group that stays in the villages. As all villages similarly suffer from shortages of rice stock, cash from fish is generally used for purchasing rice. In another study –also in Cambodia-, poor rural households were found to engage in small-scale fishing in common-pool resources as a second major activity. This produced 31.2% of their total income—just below the wage of day labourers at 32.5%—and provided income opportunities, in particular during the lean season after rice harvesting, when work for labourers is not available (Chamnan et al. 2009).

Yet the presence of cash does not necessarily mean that these fishing communities are food secure. Poverty profiles conducted in Côte d'Ivoire suggested for instance that food insecurity can be endemic among artisanal fishers in terms of availability and quality of food, and diversification of diets (Pittaluga, 2002, p.3); and the example of the fishing communities on the shore of Lake Victoria discussed in the next section also suggests that prevalence of under-nutrition can indeed be observed among small-scale fishers in some cases despite fish-related activities providing opportunities for livelihoods. This high level of under-nutrition amongst some fishing communities may be due to their location in marginalised remote rural areas where provision –or access to- health systems are limited (Allison et al. 2011; Mills et al. 2011; Béné and Friend 2011), and/or because they are particularly exposed to risks related to diseases including malaria, water-borne diseases (e.g. schistosomiasis), STDs and HIV/AIDS (Allison and Seeley 2004; Béné and Mertens 2008; Parker et al. 2012)[12], which

[12] Prevalence of these diseases is often higher in fishing communities than in the rest of the population (Kissling et al. 2005)

undermine the health benefits they may gain from direct consumption of fish (e.g. Seeley and Allison 2005; McPherson 2008). In addition, despite the fisheries opportunities, these may not be sufficient for full FSN.

These mixed results are in agreement with the wider literature (outside fisheries): while it is recognized that increases in income are usually associated with increases in energy intake from staple foods, especially for the poorer households and with non-staple food consumption, especially meats (Alderman 1986)[13], the literature has also established that increase in household income, while improving access to food, does not always directly contribute to improved nutritional well-being (von Braun et al. 1992). Indeed the additional income may be spent on foods of low nutritional value or even on non-food items (alcohol, cigarettes, etc.), especially if the additional income comes through men in the household (Quisumbing et al 1995). Intra-household differences to access to fish and other food are important in FSN.

In aquaculture, the situation seems slightly less ambiguous. Several recent studies highlighted in particular the positive effects of revenues from aquaculture in increasing consumption of staple foods (Jahan et al. 2009) and foods from other animal sources (Dey et al. 2006), leading to an increase in total energy intake (Kumar and Dey 2006). A study in Malawi (Aiga et al. 2009) found that the prevalence of undernutrition among children was lower in fish-farming households compared to non-fish farming households. The data suggest that the factors associated with malnutrition were the lack of fat and oils, which cannot be produced through subsistence farming activities and therefore need to be purchased. Fish farming indirectly contributed to the statistically lower prevalence of underweight children in these households through the increase in purchasing power provided by the selling of the fish, highlighting once again the importance of cash income as an indirect path to food security and nutrition.

Additional factors affecting nutrition status at household level

When households lack food, fish produced from aquaculture or captured from the wild stocks, are sold for cash in order to be able to purchase essential, cheaper food items (Karim 2006; Islam, 2007). For instance in the Lake Chad area the poorest households were shown to consume a lower proportion of their catch than the better-off households and instead sell most of their fish in order to be able to purchase cheaper foodstuffs (in this case, essentially millet) (Béné et al., 2003). The direct contribution of fish to food security for the poorest households may therefore be lower than generally thought, preventing these households from accessing the whole nutritional benefits that fish offers. This suggests that in certain cases lack of access to food may lead poor household to try to secure their food security or their energy intake at the detriment of

[13] The income effect on consumption of micronutrients found primarily in meats, such as iron, is generally high while the income effects for micronutrients that come primarily from vegetables such as Vitamin A is usually lower (Bouis 1991).

their own nutritional status, raising question about the implications of certain types of household strategies with regard to micro-nutrient deficiency**.**

In other circumstances, where markets are inefficient (e.g., due to poor infrastructure, lack of access to inputs and credit) and where fish resources are in decline, the incomes from fishing may even be insufficient to purchase more than the basic starch-based staples, leaving fishing communities no better off nutritionally or in terms of food security than non-fishing communities (Kawarazuka, 2010).

Finally, primary causes of under-nutrition are more complicated than just dietary intake, with other factors such as child care practice or diseases being potentially important. For instance prevalence of under-weight children under age 5 in South Asia is perceived to be due to low social status of women (von Grebmer et al., 2009). There is no reason to believe that fishing or fish-farming communities are less exposed to these risks than the rest of the population. In fact the very high exposure and vulnerability of fishing communities to diseases (HIV/AIDS and STDs, but also water-borne diseases such as schistosomiasis and malaria) mentioned above suggests that fishing communities are in fact probably facing higher risk of undernutrition than the rest of the population.

The main conclusion that emerges from this chapter is that, although the links between fishing or fish-farming and the different dimensions of food security seem *a priori* obvious and positive, they are empirically far more complex and difficult to unpack and therefore to document. This difficulty results essentially from the scarcity of nutritional data that characterize the two sectors and from the case-specific nature of the processes involved. Despite this lack of general and conclusive evidence experts are in agreement that the act of engaging in fishing or in fish farming is likely to improve fish consumption and possibly protein and nutrient intake at the household level. In that case both the availability and accessibility dimension of food security are involved. Many other factors however contribute to alter this initial positive dynamic. For instance, if in order to be able to operate normally a fisher needs to migrate to an area where the sanitary conditions or the accessibility to quality food is lower than the place where s/he used to live before, then the potential benefit of engaging in the fishing activity may be cancelled out. Similarly if an individual invests in fish-farming and is unable to maintain his financial viability due to, e.g., recurrent outbreak of fish disease, he may eventually end up poorer than he started and jeopardize the food security of his entire family.

From a food security and nutrition policy perspective, these results suggest that broader social relations and conditions have various promoting and moderating impacts on how each of the three pathways from fish to FSN operate in practice.

3.6 Producers versus consumers: food security at global level

Framing the problem

One of the key issues which needs to stay central in this whole discussion is the question of 'food security for whom?' The apparent tension that exists between producers and consumers is a good illustration of this problem: high fish prices are good for fish-farmers' and fishers' revenues (and therefore for their food security, at least in theory), but not for the consumers whose access to fish is affected by these high prices and would be increased if cheaper fish were supplied. An alternative way to frame this 'producers versus consumers' dilemma is to look at it from a trade perspective. Trade is the second of these 'prisms' that were highlighted in the introduction. Trade crystallizes and balances the tensions between the needs and interests of different groups. Indeed, can fish trade benefit both producers and consumers at the same time? As we will see below, while the trade theory suggests that it is the case, the reality is much blurrier. In the case of FSN, irrespective of the way we frame it ('producers vs consumers' or 'fish trade'), the issue comes down to the questions: can we secure or improve the food security and nutrition of one group without compromising the food security and nutrition of the other?

International fish trade and food security: rhetoric and evidence

Arguably, one of the most debated issues related to fish and development is the question of international fish trade and its potential impact on food security. This concern was raised many years ago, as illustrated by Kent's remark: "trade tends to move fish away from poor people" (Kent, 1997, p.403). Several years later, the Norwegian Agency for Development Cooperation (Norad) commissioned a global study entitled "Fish trade for the people: Toward understanding the relationship between international fish trade and food security" (Kurien 2004) while FAO was organizing at the same time an "Expert consultation on international fish trade and food security" (FAO 2003). The debate is therefore not new. Ten years after, in 2013, the community remains divided between two polarised narratives, partly because even these major studies were not able to come to firm conclusions.

On one side, following the general theory on trade, the first narrative claims that international fish trade is good for poverty alleviation and food security. Fish export, it is argued, can act as an engine of growth for developing countries endowed with large fish resources and provide them with important sources of hard cash flow, which can then be used to service international debt, fund the operations of national governments, and import large volumes of (low cost) food to supply the domestic market, thus contributing to national food security (EU, 2006; FAO, 2007, Valdimarsson, 2003; Bostock et al. 2004; World Bank, 2004; Valdimarsson & James, 2001)[14]. Additionally,

[14] If these imported food commodities are nutrient poor, however, there is a risk that they contribute to, or even worsen, the nutrient deficiency that may already be affecting the population.

fisheries trade can contribute indirectly to food security through the creation of new jobs and the increase of incomes/revenues within the sector and through secondary employment such as processing plants workers (Kurien, 2004).

In contrast, the 'anti-fish trade' narrative contends that international fish trade impacts negatively food security and livelihood options for the poor by taking away fish from the local economy and the local populations (Kent, 1997; Jansen, 1997; Abila and Jansen, 1997; Ruddle 2008). It is further argued that fishing agreements signed between high income countries (importers) and developing nations (exporters) usually take advantage of the developing states without providing fair returns (Kaczynski and Fluharty, 2002; UNEP, 2002). These different authors cite as evidence the apparently minimal economic benefits that developing states have managed to derive so far from these agreements (Porter 1999, Petersen 2003), pointing out the low rates of revenue reinvested back into the sector and the low usage of local processing facilities and infrastructure by foreign operations. In addition global-trade fishery policies are said to lead to losses of local jobs and to affect adversely the development of the domestic fishing industry (Jansen, 1997; Porter, 2001; Kaczynski and Fluharty, 2002; Abila, 2003). Finally, some theoretical analysis suggests that revenues generated from fish exports in countries where the high-value market chain is dominated by a small number of firms, or by foreign investors, may 'leak' out of the national economy in the form of capital flight and expenditure on luxury imports, leaving little to be reinvested in development (Wilson and Boncoeur, 2008).

So, does international trade reduce or accentuate food insecurity? Two recent comprehensive reviews conducted independently converged towards the same findings (Allison et al., 2013; Arthur et al., 2013). Their conclusion is: at best, the evidence is unclear and contradicting, and at worse no strong / rigorous evidence exists to substantiate either of the two narratives. We are quoting here the conclusion of the Arthur's review:

> "The findings that emerge from this heterogeneous body of literature are relatively inconsistent, reflecting essentially the lack of tangible evidence and the subsequent unsettled debate that characterises current discussions." (Arthur et al. 2013, p.17)

Table 3.5 extracted from Allison et al. 2013 –and derived from the Norad's 2004 global analysis (Kurien 2004)-, can help clarify the situation. While there is little doubt from the 11 case studies included in the initial Norad analysis that international fish trade has positive effect on trade revenues (see for instance the first column 'impact on trade revenues' in Table 3.5) and possibly on job creation ('impact on fish workers'), these revenues don't seem to translate into positive outcome in terms of food security (column 'impact on fish consumers'). The case of the Nile perch Lake Victoria fishery shared between Kenya, Uganda and Tanzania in East Africa is particularly illustrative in this regard. The fishery generates large amounts of revenues due to the export of Nile perch to European market, estimated to vary between US$ 250-400million a year

(Thorpe and Bennett 2004). Yet Gehed et al. (2008) found that the Ugandan and Tanzanian districts located on the shores of the lake were systematically displaying higher rates of stunted and wasted children than those in the rest of the countries (Table 3.6).

Table 3.5. Direct and indirect impacts of fish trade on food security (Source: Allison et al. 2013, adapted from Kurien, 2004).

	Impact on trade revenues	Impact on fishers	Impact on fish workers	Impact on fish consumers	Impact on fish resources
Nicaragua	+++	+++	++	+	---
Brazil	+	+++	++	+	---
Chile	+++	+	++	-	-
Senegal	+++	++	+ and -	--	---
Ghana	---	--	+ and -	--	--
Namibia	+++	+++	+++	+	+
Kenya	-	+	+ and -	---	---
Sri Lanka	++	++	++	+++	--
Thailand	+++	++	+++	+	---
Philippines	++	-	+ and -	-	---
Fiji	+++	+	+	+	-

+ small positive impact ++ significant positive impact +++ large positive impact
- small negative impact -- significant negative impact --- large negative

Table 3.6. Rate of stunted and wasted children on the Lake Victoria shores (source Medard et al. 2002; Gehed et al. 2008).

Country	Stunted		Wasted	
	Survey	National average	Survey	National average
Uganda	43.3% (194)	39%	4.7% (181)	4%
Kenya	26.7% (120)	38%	3.4% (119)	6%
Tanzania	44.5% (236)	38%	3.4% (235)	3%
Totals	40.2% (550)		3.9% (545)	

In other words, depending on the criteria used to assess the 'success' of international fish trade, the conclusions may differ quite dramatically, even when one is looking at the same case: from a revenues perspective the Nile Perch fishery is a success; from the perspective of food security of the local population it is a failure. Some would argue further that even in the case of positive impacts, a more in-depth analysis would unearth a more complicated or mixed story. In particular in the case of 'impact on fishers' which seems to be characterized by a general positive trend across the case study (cf. Table 3.5), a closer look reveals a less clear-cut situation. Coming back to the example of the Lake Victoria's fishery, Geheb and his colleagues, while emphasizing that the Nile Perch fishery has created large numbers of jobs in the sector, also recognized that "the relationships between fishermen [and the factories] are highly unequal. Conditions within the fishery are tough, and income from it very unevenly distributed" (Geheb et al., 2008, p.15).

In the light of these analyses one could hypothesize that the lack of apparent relationship between the huge revenues that are generated by international trade and the food security of the local population reflects the structural failure of the fish export sector and national institutions to ensure an effective (re)distribution of the fish trade revenues and a non-harmful mode of operating.

Finally the last column on the right (‘impact on fish resource’) could be interpreted as the ‘last straw on the camel’s back’, given the overall largely negative evaluation that it displays. If, as mentioned earlier, sustainability of the resource is a *sine qua none* condition for food security, international fish trade seems to work against food security. What is not clear from this evaluation, however, is whether this negative impact on the fish resources reported across the Norad study’s cases is the consequence of the international fish trade *per se*, or the manifestation of the more general world fisheries crisis that is often referred to in the current literature (Costello et al. 2012; Burgess et al. 2013 –see also section 3.4). Alternatively some would argue that, perhaps, international fish trade and world fisheries crisis for some fisheries are one single and same issue.

From ‘pro-cash remunerative fish trade’ to ‘pro-food security fish trade’

Today, increasingly, fish processing factories (often owned by companies in importing countries or multinational corporations) operate their own fishing vessels, hire their own crew or own fish-farming labourers, control other enterprises relating to fish supply acquisition, transporting fish, product distribution and export marketing (Jansen, 1997; Crosoer et al. 2006, Goss et al 2000, Felzensztein and Gimmon 2007). As in other agri-food industries (Dolan and Humphrey, 2000; Gibbon and Ponte, 2005), this process excludes an increasing number of small-scale producers (fishers and fish-farmers) and fish-processors who were already operating on the margin of the export sector[15]. Contract farming arrangements offer some options for small-scale producers in some cases but these are usually difficult to sustain with the unequal powers of the parties (Goss et al 2000). Cluster farming arrangements (Umesh et al 2009) also offer another option. In general, however, the small-scale independent farmers become less and less able to keep up with the level of investments and technical conditions requested (e.g. compliance to HACCP procedures, or to eco-labelling (Belton et al 2011) reducing further their competitiveness and their chance to integrate the global market (Gibbon, 1997; Henson et al., 2000; Henson and Mitullah, 2004; Kambewa et al. 2008). An alternative to the imperative for global market integration exists, however. This alternative is to re-orientate fish trade toward regional or domestic markets (Box 3.4).

[15] Gereffi et al. (2005), in their typology of governance in global value chain, observe that sectoral re-organization that leads to greater vertical integration is generally associated with increasing power asymmetry amongst the different actors of the chains, usually at the expense of the lower levels (producers).

Box 3.4. Benefits of local fish trade

Fish from common-pool resources are widely traded in local markets all over the world, contributing in large part to the local population's nutritional security. For example, food consumption surveys in Cambodia (Chamnan et al. 2009) showed that 54% of the households consume fish every day, making fish the second ranked food after rice, in terms of frequency in the diet. Chamnan et al. (2009) observed that the majority of these fish were purchased in the local markets and were originally supplied by small-scale fisheries. The same study estimated that fish and other aquatic animals contributed on average 37%, 51%, 39% and 33% of the total protein, calcium, zinc, and iron intake, respectively, of the women in the area surveyed, confirming once again the importance of fish in the diet as a major source of protein and micronutrients but also the central role of local fish trade in ensuring the access to this commodity. In sub-Saharan Africa the very limited information available also underlines the importance of local trade. In the Democratic Republic of the Congo for instance, data collected from the region of Lubumbashi revealed that households consume fish on average 5.17 times per week (31% consumed fish every day). In these areas, the species most frequently eaten are small dried fish from Lake Tanganyika or from smaller lakes in Zambia. These are traded and sold locally (Mujinga et al. 2009).

A more regional or domestic-oriented fish trade would act positively in terms of food security of both urban and rural poor consumers and small-scale producers for a series of different but intertwined reasons. First as we mentioned above the small-scale operators have difficulties to stay connected to the increasingly stringent conditions imposed by the importing countries' markets and international food safety regulations and as such are pushed out of the global trade arena. A more domestic or regional market-oriented trade would allow these small-scale operators (especially these operating at the fringe between formal and informal markets) to re-engage with the trade opportunities offered by this different strategy, and certainly boost their revenues. The large number of women engaged in these small-scale enterprises (who have been increasingly marginalised by the internationalisation of the fish trade (e.g., Nayak 2007) suggests that these women would be one of the main groups which would benefit from a re-orientation of the trade towards domestic or regional markets.

From the demand (consumers) side, the regionalization or domestication of the fish trade would also have tremendous positive effect. It would in particular contribute to help reducing the growing deficit between the demand for fish in developing countries and the supply, which so far is not satisfactorily filled by low value fish imports (Fig.3.8). It could also in the specific case of Africa stimulate the production of aquaculture which has had difficulties in taking off. The increased demand for fish by the growing urban (and rural) population could boost investments of, e.g., peri-urban aquaculture (Brummett et al 2004).

The re-orientation of fish trade toward regional and domestic markets would not however simply mean redirecting the fish commodity itself toward local consumers.

Very importantly it would also result in redirecting private and public resources as well as policy makers' attention toward these small-scale operators. Indeed, although the pro-fish trade supporters are correct to point out that trade of high value fish exported to rich countries' markets (Europe, Japan, North America) does not necessarily remove *directly* fish from the poor countries consumers' plates (since they often involve different species and/or different products), it does *indirectly*, in a more surreptitious way, by distracting national and international policy-makers' attention, research and development efforts, management support and donors' money away from the small-scale fisheries and aquaculture producers and traders. A switch of emphasis from international to regional/domestic fish trade would certainly help refocusing these limited resources which have been so far used to promote cash remunerative fish trading activities benefiting a few, toward a more 'food security' friendly type of fish trading activities benefiting a lot of people (see Box 3.5). In fact one could even envisage that what has been so far presented as an irreconcilable tension between producers and consumers could in these specific circumstances become a win-win approach.

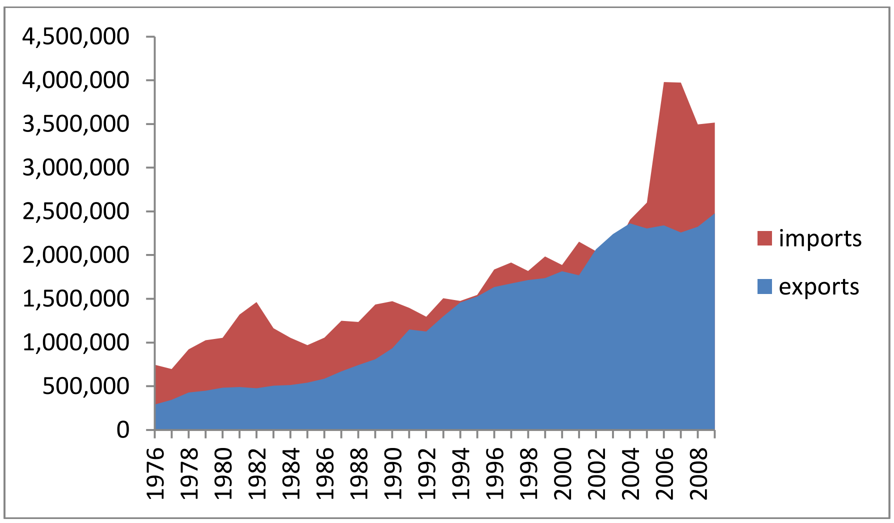


Figure 3.8: Fish and seafood imports and exports in volume (thousands of tonnes) for 53 LIFDCs (Data source: FAO FISHSTAT, 2012- Figure produced by Allison et al. 2013).

Box 3.5 Why an Africa-to-Africa trade?

Africa is a very important potential fish market for its own production. In Africa, more than 200 million people regularly eat fish (Heck et al. 2007), and this figure is rising as the African population is growing fast and its urbanised segment is expanding even faster. It has been estimated that in order to maintain its current consumption level, Africa will need about 27% more fish per year in 2020 (WorldFish Center, 2005). If one were to try to improve the Africa per capita supply in order to match the world current figure (14.2 kg per capita –excluding China) by 2020, another 10 million tonnes of fish would have to be supplied per year in Africa at current levels of production and export.

Although demand for fresh fish is increasing in Africa (in particular in urban areas), smoked, dried and low quality processed fish still represents by far the largest majority of the fish consumed by the rural populations but also by the low income classes in urban areas. These low value fish are caught and processed by small-scale operators, working in labour intensive, mostly self-employed enterprises. In fact, more than 95% of the women and men fishers and fish processors in sub-Saharan Africa are artisanal operators who trade fish locally (Overa, 2003; Gordon, 2005; Abbott et al. 2007). If one accounts not simply for coastal full-time professional fishers and whole-sale merchants, but includes also the seasonal inland fishers, fisher-farmers, part-time or full-time small-scale fish processors and traders, it is between 6 and 9 million households that are engaged to various degrees in fish-related activities in sub-Saharan Africa (Heck et al. 2007). At the present time, however, the bulk of these small-scale, unorganised, and unskilled African producers and traders are excluded from the high value fish trade activities promoted by the current trade model, as they are unable to comply with the food quality-standards requirements imposed by international trade institutions (e.g. WTO) and the importing countries (Henson et al., 2000; Gibbon and Ponte, 2005; Kambewa et al., 2008).

3.7 Aquaculture: as addition, alternative and threat to fisheries

The development of aquaculture has been a major food producing phenomena, and experts inside and outside the fish sector hold divergent views on its impacts, not the least on food and nutrition security. Staunchly pro-aquaculture views regard the huge growth in fish production as a triumph; many fisheries experts and environmentalists regard much of this success to have led to the detriment of fisheries; and the neutral view is that aquaculture has been successful but its progress needs to be greatly tempered by a more cautious and more egalitarian approach. All these views contain some truth, and the tensions among them have moderated some, e.g., environmental impacts, but not all of the concerns, e.g., the FSN impacts.

From a positive FSN perspective, aquaculture production for cash has had a positive impact on the FSN of the small-scale farming households (3.5); and production is more stable than in many earlier boom and bust industries due to greater knowledge, experience and technical support (3.4). In this Section, we explore in more depth the interactions between fisheries and aquaculture, with respect to their FSN implications.

In theory aquaculture adds to fisheries and fisheries and aquaculture complement each other in improving the food security and nutrition of the world population; and in practice it is broadly the case as both sectors contribute respectively approximately 50% of the world fish supply (FAO 2012). In some local cases, however, the interaction between fishery and aquaculture has been competitive or even has turned into a negative externality, rather than being purely additive or complementary. Economists would point out that competition is good, in particular for consumers. When aquaculture pushes down the prices of wild fisheries products for instance, one could argue that the outcome is desirable for the consumer, although likely not for the environment[16]. Yet in other cases the interaction between aquaculture and wild fisheries is far more detrimental. We discuss these different positive and negative interactions below from a food security and nutrition perspective. We focus on four interactions: seed and broodstock, fishmeal and fish oil, competition for land, water and other common resources, marketplace and trade interactions,

Capture of seed, juveniles and broodstock

Most aquaculture starts with the use of seed or juveniles from the wild, evolving to become less reliant on such inputs as the species are domesticated and raised fully in captivity. For many species, capture-based aquaculture (CBA) is still a globally significant activity that can involve the capture of wild individuals, either as broodstock, or as early life stages for on-growing under controlled conditions. CBA is practiced on a diverse range of freshwater and marine species of fish and invertebrates and is a highly significant economic and social activity in its own right, often creating many jobs for poor people, although often of a transient nature as the aquaculture system develops. However, this practice is recognized to result in negative impacts on fisheries. For example, under certain conditions and especially for aquatic species with low reproductive capacity, the mass capture of wild seed, juveniles or broodstock may have a negative impact on recruitment to wild fisheries (Hair et al. 2002); bycatch of other species along with target species can lead to biodiversity loss, potentially affecting wild fisheries; destructive fishing practice for collection of wild seed or broodstock can damage fisheries habitat (see Box 3.5).

Box 3.6. Capture of wild seed: the case of shrimp in Asia and in Latin America

Despite improvements in hatchery production of seed, shrimp farming in some countries still rely on seed collected from the wild, especially for species such as *Penaeus monodon* for which the lifecycles are still difficult to close full in hatcheries and so they are routinely captured as broodstock in many countries. The collection of seed from the wild has impacted the wild populations of both targeted species and the species that are caught incidentally and discarded as bycatch. For instance, in Nicaragua, collection of seed from the wild is claimed to be a major factor responsible for the reduction in shrimp and other fisheries production.

In Asia, which produces about 80% of the world's farmed shrimp (Fishstat plus, FAO, 2010c), until recently, farming of tropical marine shrimp was based almost totally on wild caught *Penaeus monodon* broodstock and seed. It has now been replaced partially by hundreds of billions of hatchery produced seed of *Litopenaeus vannamei* (Briggs et al 2004). Despite this, 30% of farmed Asian shrimp, mostly *P. monodon*, still depends on wild populations to provide seed and most of the broodstock requirement.

Sources: (Briggs et al 2004; Soto et al. 2012)

[16] We would still have to demonstrate, though, that the gain enjoyed by the consumers is not cancelled out by the loss in livelihood faced by the affected fishers. In addition, ecological economists would argue that the current price of fish does not incorporate the costs of environmental externalities. To force the price down to compete with fish produced from aquaculture could exacerbate the underpricing.

Aquaculture feeds and the use of fishmeal and fish oil

In aquaculture, the use of fish from the wild in fishmeal and fish oil to produce fish has been the cause of major public controversy, with and without good reason (Wijkstrom et al 2012). In 2008 only 46.1% of global aquaculture production was dependent on the supply of external nutrients such as fishmeal. Low-trophic level species (omnivores) mostly farmed in developing countries use much less supplementary feeds and fishmeal, while higher trophic level species are still dependent on fish from the wild for fish meal and oil in formulated feeds, although large differences exist between countries as to the sources and efficiency of use of the wild fish resources in feeds (Tacon et al 2011). The use of fishmeal in aquaculture feeds is expected to decrease with time, thanks to increasingly effective development and use of fishmeal replacers, including plant proteins, waste products from fish and terrestrial animals and use of better/improved breeds of aquatic animals with better feed conversion (Tacon et al 2011). Fish oil, which cannot be readily replaced, is expected to continue to slowly increase. The very high share of production costs due to formulated feeds also offers hope of a continued push on technology development for more affordable and sustainable feeds.

In terms of food security, producers in Asia, especially China, Viet Nam, India, Indonesia and Bangladesh, have benefited from the development of culture of low trophic-level species, such as carps and barbs, tilapias and Pangasius catfish, in easing dependence on high-protein feeds, and this has thus reduced the vulnerability of their industries to inputs. In Asia, fish culture in semi-intensive systems mainly depends on fertilizer nutrients. Several studies of small-holder aquaculture in Bangladesh, India, Thailand and Viet Nam indicate that livestock wastes are the most commonly used inputs as organic fertilizers or supplemental feeding inputs (Edwards, 2008a,b, 2009a,b,c,d, 2010a,b,c,d). Fish yields may not be optimized for a variety of reasons, but livestock wastes purposely used in ponds or draining into them support the production of most cultured fish in Asia (Little and Edwards, 2003).

Of the world's total catch of fish, approximately 22% goes to produce fishmeal and fish oil (Fishstat plus; FAO 2010; Tacon et al., 2011). Small pelagic species, in particular anchoveta, are the main contributors for reduction, and the volume of fishmeal and fish oil produced worldwide often fluctuates annually according to the fluctuations in the catches of these species. In addition to fishmeal and fish oil, 'low-value' fish (also called "trash fish" [17]) are also used as feed for aquaculture, especially in Asia (Box 3.6).

Box 3.6 Use of low-value fish as feed

Marine finfish aquaculture in Asia has been developing rapidly at around 10 percent per annum, contributed 4 percent of the global finfish production annually over the last decade, and is the

[17] The term "trash fish" is unfortunate because many species involved are in fact species that would be suitable for human consumption if allowed to grow and some could be used as food fish directly.

fastest growing protein-producing subsector in Asia. However, the subsector is heavily dependent on "trash fish" or "low-value fish", almost always as the only food source of the cultured stocks. It has been estimated that the marine aquaculture sector in China in 2000 consumed about 4 million tonnes of low-value fish (D'Abramo, Mai and Deng, 2002). Demand for trash fish or low-value fish is likely to increase unless viable alternatives are made available and used, and unless the efficacy of use of these feed sources is improved (Edwards, Tuan and Allan, 2004). In the Asian region, one of the fastest growing mariculture commodities is grouper (about six species in all), and in 2005, grouper culture accounted for about 65,000 tonnes. The total use of low-value fish by the aquaculture industry in Viet Nam by the year 2013 could be about one million tonnes (De Silva and Hasan, 2007). This is a contentious issue from a resource use view point, reflected in the very high fish to fish conversion rates.
Note: low value fish are also considered a major bycatch issue but, at least in artisanal fisheries, much of this goes to household food security through direct consumption or sale.

Source: Soto et al. 2012

Since the early 1990s, the proportion of fish production used for non-direct human consumption has decreased: while in the 1980s, more than 30% of the fish landed was still destined to non-direct human consumption, this share decreased to 27% in the 1990s, and this decline accelerated in the 2000's to reach 14% in 2010[18]. As a consequence, the ratio of wild fish input via industrial feeds to total farmed fish output has fallen by more than one-third from 1.04 in 1995 to 0.63 in 2007 (Naylor et al., 2009).

Yet fishmeal and fish oil continue to be the major sources of dietary protein and lipid within compound aquafeeds. An estimated 97,400 jobs have been created in feed fisheries, fishmeal/fish oil industries, fish/shrimp feed industries plus many more in the aquaculture enterprises using the feeds (Wijkstrom et al 2012). From a food and nutrition security perspective, and in addition to the importance of these jobs, a key question is whether these fish currently used for non-direct human consumption would not be more 'efficient' if they were used for direct human consumption.

The first point in trying to answer this key question is the efficiency of fish versus other animal protein production. Table 3.5 shows that fish score well in terms of conversion efficiencies compared to the main other sources of animal protein. This situation derives from the fact that, in general, fish convert more of the food they eat into body mass than livestock. Poultry for example, convert about 18% of their food and pigs about 13%; in contrast fish convert about 30% (Hasan and Halwart 2009). Most of this difference reflects the fact that fish are poikilotherms (their body temperatures vary along with that of the water in which they live) and do not expend energy maintaining a constant body temperature. Moreover, because aquatic animals, especially finfish are physically supported by the aquatic medium few resources are expended on bony skeletal tissues, and a larger part of the food they eat can be allocated to body growth.

[18] This decrease is primarily due to the reducing volumes of raw materials used for fishmeal, and the increased use of more cost-effective dietary fishmeal replacers (Davis and Sookying, 2009; Hardy, 2009; Nates et al., 2009; Quintero et al., 2010).

Table 3.5. Feed conversion efficiency of the major animal foods. Calculation based on average US feed requirement in 1999

Commodity	Milk	Carp	Eggs	Chicken	Pork	Beef
Feed conversion (kg of feed/kg edible weight)	0.7	2.3	4.2	4.2	10.7	31.7
Protein content (% of edible weight)	3.5	18	13	20	14	15
Protein conversion efficiency (%)	40	30	30	25	13	5

Source: Hall et al 2011. Protein conversion figure from Smil 2001

Despite this relatively high efficiency compared to other farmed animals, the rate of conversion of fishmeal to fish is still a source of concern. On average when both carnivorous and omnivorous species are considered, 1.90 kg of wild fish transformed into fishmeal is needed to produce 1 kg of farmed fish. This means that on average, for every kg of farmed fish produced, 2 kg of wild fish are needed. This average value varies however quite substantially depending on the fish species considered. For omnivorous fish, the rate of conversion is down to an acceptable figure of 0.2 to 1.41 kg of wild fish for 1.0 kg farmed fish. For carnivorous however the rate is far higher: 1.35 to 5.16 kg of wild fish necessary to produce 1.0 kg of farmed fish (Naylor et al. 2001, Boyd et al 2007). From a pure food security perspective –and in particular from the availability dimension of food security- the decision to use fishmeal to feed these carnivorous higher-trophic-level fish and crustacean species is still controversial.

Several of the higher-trophic level species such as salmon, trout and shrimp) are species with high market values, and are almost exclusively sold to wealthier consumers from developed countries who are not necessarily nutrient-deficient. One could argue that the small pelagic fish species that are used to feed these higher-trophic-level fish and crustaceans (which are particularly rich in nutrients and PUFAs) would certainly have a greater impact in term of food security and nutrition if they were sold on the local markets of LIFDCs, rather than to these well-off and food and nutrient secure customers

The policy actions required to address this market failure seem clear: with an expected increase in aquaculture production to meet fish demand, the use of fishmeal in fish feeds needs to be better controlled. Much of the “forage fish” used to produce fishmeal is edible. If this fish could be made available as low-cost food to the poor in LIFDCs, no doubt that we would have a better use of these forage fish than their current commercialization on developed countries’ already well supplied markets. Local commercialization seems possible. In Peru, directed efforts to divert part of the Peruvian anchoveta fishery to direct human consumption are starting to succeed, although currently only 2% of the catch is directly consumed (Pikitch et al 2011). Research to find alternate sources of protein for replacing fishmeal in aquaculture feeds and poultry would also certainly contribute to improve this current failure.

Competition for common resources (land, water) and services

Aquaculture and wild-harvest fisheries may have spatial interactions; both subsectors can overlap and compete for port access and use of land and water habitat (Hoagland and Powell, 2003). The siting of aquaculture facilities for instance, such as ponds, net pens, longlines or rafts for seafloor grow out, may displace some forms of fishing activity. As more space is progressively allocated for aquaculture, smaller stocks are available for fishing and more congestion is likely to affect the fishing activities in the areas remaining open for wild harvest. Conflicts are particularly common when aquaculture is introduced into a region where fishery activities are already established (Marshall 2001, Soto, et al. 2001). For example, new cage-culture farms can be placed in areas that were formerly used by fishers directly for fishing or as passage to fishing areas (Halwart et al 2007).

In many instances, fishers and fish farmers gain access to the aquatic system under different sets of rules and legal rights. Rights may even differ among different types of aquaculture, having the effect of favouring some users and types over others, e.g., especially protecting the larger scale operators (Ramchandran 2012). Where such disparate property systems arise and uses are partially or fully exclusive, conflicts are bound to arise. If property rights are ill-defined or if they are spread across a large number of users, solutions may be difficult to find. On the other hand it may be that in some specific circumstances positive externalities or synergies can emerge from the interactions between fisheries and aquaculture. These, however, are rare (Box 3.7).

Box 3.7 Examples of conflicts and synergies between fisheries and aquaculture in coastal areas.

In Chile, there are often conflicts between salmon farms and artisanal fishers for the use of coastal marine areas or access to these (Soto, Jara and Moreno, 2001). Often, salmon farms do not allow the latter to approach farms due to fear of robbery or vandalism to cages, while the fishermen complain that the farms are not allowing them to reach their traditional fishing grounds. A similar case can be described for shrimp farming areas in the Gulf of Fonseca, Nicaragua, where armed guards often keep fishermen away from large farms, not allowing access to their former and potential fishing channels and lagoons within the mangrove.

On the other hand, in some communities of the Asia-Pacific region, coastal artisanal fishers' livelihoods and sustenance depend on the coastal cage-culture farmers, who provide, almost on a daily basis, the only source of income, by providing trash fish to feed cultured stocks of high-value marine species such as groupers. The artisanal fishers may operate a variety of gear types, including large, stationary, semi-mechanically operated lift nets; gillnets; cast nets and weirs, and they can coexist well with aquaculture. This complementarity and livelihood interdependence has been ongoing for decades, without any one group being disadvantaged, and most of all, without apparent harmful impacts on the stocks.

Source: Soto et al. 2012

If FSN were to be the main objective, although it rarely is, the debate may not be as simple as we might initially imagine though -unless of course the aquaculture business under consideration is a highly capital intensive operation that exports the majority of its farmed fish outside the country, and the fishers who have been displaced by the development of this aquaculture business are small-scale fishers who supply the local market. In that case there is little FSN dilemma and preference should be given to the small-scale fishery. If however the aquaculture is a relatively small or medium scale type of business, which creates a sizeable number of local jobs and commercializes its production to the local market, then both the small-scale fishery and the aquaculture business can claim to be contributing to the food security and nutrition of the local population (including both producers and consumers).

Interactions through markets and international trade

Provision of food fish from aquaculture can complement and supplement that provided by fisheries. Aquaculture can increase availability of good-quality food and has increased the awareness and consumption of fish products worldwide. In some cases, aquaculture can ease the pressure on wild fish stocks when fisheries delivery fails or is of less quantity or poorer quality. Growth in catfish and tilapia aquaculture has satisfied market demand in the whitefish markets, as harvests of the wild product have decreased considerably. In these cases, the aquaculture sector has emerged to increase fish supplies and try to meet the market demand.

However, expansion of aquaculture also has impacts on markets for wild fisheries. For example, prices paid to wild salmon fishers and processors in the US fell dramatically as world farmed salmon production expanded during the 1990s, causing significant economic difficulties for Alaskan salmon fishers, processors and fishing communities (Knapp et al. 2007). Similar trends were also observed for wild and aquaculture shrimp (Béné et al. 2000).

On the other hand, with aquaculture production dominated by developing countries, it is no surprise that fish imports are mostly by developed countries, currently responsible for 77% of the total import value. This dominance presents a challenge to exporters from developing countries trying to adhere to market access requirements as a prerequisite for entering international markets (Delgardo et al 2003). Prominent cases in recent years have involved developed country claims over the use of the name “catfish” for Pangasias catfish from Vietnam, and antibiotics and subsidies for shrimp farming in several countries. In addition, the changing nature of these market access requirements, including the emergence of private and voluntary standards and requests for certification and labels for various purposes, puts additional pressure on small-scale producers, processors and exporters in developing countries without necessarily offering higher prices to offset the additional costs incurred – see Chapter 5.

3.8 Small versus large scale

Why is scale important when it comes to food security?

The issue in this chapter is to explore the possible relationship between scale of operation and the capacity of the production system to contribute to food security and nutrition. In the farming context this issue has already been discussed in the HLPE report "Investing in smallholder agriculture for food security". In fisheries the question is: do large scale, industrial, fleets have a larger (or smaller) potential to contribute to food security and nutrition than small-scale fisheries? Similarly, in aquaculture: do large commercial aquaculture systems have more potential to address the FSN than smaller holders? These questions have important policy implications, in particular because governments and development agencies have often a predetermined view on the question. For many decades for instance small-scale fisheries have been perceived as a 'remnant of the past', doomed to disappear with 'modernization', and many governments (even in developing countries) have systematically disregarded their small-scale fishery sector and forcefully supported the development of large, industrial fleets (Bailey 1980; Platteau 1989) sometimes with the indirect help of the research community who has for many years focused its effort on data-rich developed countries' fisheries (Mahon 1997). As far as international development agencies are concerned, the FAO has also for many decades contributed to this biased agenda -and it is only recently that it refocused its interest toward the small-scale fisheries (FAO 2005). The World Bank is however still resolutely supporting large, industrial activities.

In a great contrast, in aquaculture the international community (researchers, bi- and multi-lateral development agencies) have until recently purposefully supported the development of small-scale, subsistence aquaculture both in Asia and Africa (Muir 1999, De Silva and Davy 2009, Bondad-Reantaso and Prein, 2010).

Fisheries, scale, and food security

In section 2.2 of this report, small-scale fisheries were defined (in contrast to larger scale operations) as low capital input activities, low capital investments and equipments, labour intensive operations, and low productivity. In 1980 David Thomson proposed a comparative analysis of large versus small-scale fisheries (Thomson 1980), based on a series of key indicators and accompanied with a very memorable infographic. The Thomson analysis was then updated several times (Linquist, 1988, Berkes et al 2001, Pauly 2006, FAO 2012, Kolding et al 2013). Thomson's study and subsequent update provides a good starting point to discuss the contribution of small versus large-scale fisheries in relation to food security. In particular the relevant indicators in relation to FSN are: global estimates of employment (since employment especially amongst unskilled labour is expected to improve accessibility to food), catches (related directly to availability), bycatch and discards (availability and utilization), fish caught for human consumption (availability), employment created through investments (accessibility) (Fig.3.9).

	Large-scale company-owned	Small-scale artisanal
Number of fishermen employed	Around 2 million	Over 30 million
Marine fish caught for human consumption	Around 40 million tonnes annually	Around 40 million tonnes annually
Capital cost of each job on fishing vessel	$ 30 000 to $ 300 000	$ 100 to $ 5000
Bycatch discarded at sea	Around 8 million tonnes annually	Around 2 million tonnes annually
Marine fish caught for industrial reduction to meal and oil, etc.	Around 15 million tonnes annually	Almost none
Fuel oil consumption	30 to 40 million tonnes annually	3 to 15 million tonnes annually
Fish landed per tonne of fuel consumed	1 to 2 tonnes	3 to 15 tonnes
Fishermen employed for each $1 million invested in fishing vessels	3 to 30	200 to 10 000

Fig.3.9. Updated Thomson table comparing small and larger fisheries. Source: Kolding et al. 2013, derived from Thomson 1980.

Number of fishers employed

Based on the latest update of Thomson's analysis an estimated 32 million people are directly engaged in some forms of fishing activities in the world. Over 90% of these are employed in small-scale operations. As such, employment in small-scale fisheries is several times higher per ton of fish landed than in large-scale fisheries. Fig.3.1 highlighted conceptually the importance of employment as a critical indirect component of food security through its accessibility dimension. The estimate shown in Fig.3.9 suggests than in that regard small-scale fisheries are far more determinant than large scale operations with respect to food security.

Fish caught for human consumption

Although large-scale fisheries land more fish overall (approx. 55 million tonnes, compared to 48 million tonnes for small-scale fisheries), almost every single fish caught by small-scale fisheries is destined to direct human consumption, while only 80% of the industrial fleets' landings is used directly for human consumption. Overall it is estimated that, in absolute terms, small and larger scale fisheries contribute broadly the same amount to direct human consumption (about 45 million tonnes annually). This is an important result as often large-scale fisheries are perceived (in particular by developed country policy makers) as the main providers of fish for consumers, due to their high production capacity. The large number of small-scale fishers largely compensates this, making small-scale fisheries as eminent as the larger fleets in term of availability of fish. In addition a substantial proportion of these small-scale fisheries' landing is directed at developing countries' consumers in local or regional markets (see Section 3.6 'on producers versus consumers'). For inland fisheries, Mills et al. (2011) estimated that 94% (13 million tonnes) of small-scale inland production is consumed within the country of origin.

Bycatch discarded at sea

The global discards (caught fish dumped overboard due to low quality, partial damage or spoiling, non-targeted species or below regulated size catch) are estimated to be around 10 million tonnes (8 % of the world total catch), 80% of which comes from industrial fleets. Small-scale fisheries generate less wastage in the form of discards (about 2 million tonnes a year). In fact some artisanal fishers (for example in Mozambique) even collect and commercialize discards from large-scale vessels (Béné et al 2007). Bycatch and discards are therefore another category for which small-scale fisheries are doing far better than larger scale operations in terms of contributing to availability of food.

Fish caught for fishmeal and fish oil

About, 27 million tons of fish (34 per cent of the world fisheries catch) are ground up annually into fishmeal and oil. We discussed in Section 3.7 the potential issues related this aspect of fish industry. The fact that the vast majority of this fishmeal and fish oil is produced by large-scale fisheries is an additional argument for supporting small-scale fisheries.

Economic efficiency

Two other key-indicators of Thomson' analysis are indirectly relevant for our discussion: 'Fish landed per tonnes of fuel'; and 'Fishers employed per million invested'. Fish-catching operations are heavily dependent on fossil fuel and large-scale fisheries operation use about 10 times more fuel per ton of catch than small-scale fisheries do. Similarly in terms of number of fishers employed per million invested, the figure in Fig.3.9 suggests that between 3 to 30 men can be employed for each million invested in large-scale fisheries while in small-scale fisheries, between 200 and 10,000 job are created with the same initial investment. At the societal level it seems therefore that smaller scale fisheries are far more efficient in creating jobs and therefore contributing to direct and indirect food security for these fishers.

Some fisheries experts would probably argue that large-scale fisheries are however more efficient in terms of creating surplus for consumers. This narrative deserves more scrutiny, however: using an empirical example comparing two extreme cases Béné (2011) estimated that a modern Norwegian purse seiner would cost between 150 and 250 million Norwegian Kroner (≈US$25-40 million), while a plank boat used in the Lower

Shire valley in Malawi costs 10,000 Kwacha or less (US$75), that is, ≈30-50×$10^4$ times less. The Norwegian fishers working on the purse seiner can catch up to 180 tonnes of fish per year per fisher while the farmer-fisher of the Lower Shire Valley with his plank boat will catch during the same period about 1.7 tonnes (10^2 times less). This means that the Lower Shire farmer is actually between 3×10^3 and 5×10^3 more effective in term of kg of fish landed per USD invested than its Norwegian fellow. Although the link to food security may be less clear in these last two cases, it is about economic efficiency, which ultimately is about more food at the lower costs, thus contributing to enhance availability and accessibility.

The conclusion that emerged from the updated Thomson analysis is that when comparing large-scale and small-scale fisheries, the later seem to play a far more important direct and indirect contribution to food security and nutrition than larger-scale fisheries. Yet the amount of attention, support and resources that small-scale fisheries received (overall and per fisher) is incredibly limited, compared to large-scale fisheries.

When large-scale fisheries contribute to food security and nutrition of the poor

The discussion above indicates that support and investments in the small-scale fisheries sector are crucial in relation to food security and nutrition. Yet this does not mean that larger-scale operations cannot contribute to food security and nutrition and provide food to rural and urban poor in developing or emergent countries, as it is the case for the large-scale small-pelagic sector in South Africa (Paterson et al 2010)[19].

Sardine –also known as pilchard- is one of the most important food items in the diets of South Africans, especially the poor. The most common form is canned pilchard, which mainly come in three recipes – in tomato sauce, in chili sauce or in brine. It is the ease with which it can be stored and transported, as well as its flavour that explains the universal commercialization of the product. Another advantage is that canned sardines come in small tins of 155 g, 215 g, 400 g size all priced below one dollar US equivalent in South Africa. One can use it with bread, rice, potatoes, pap (maize meal) or even eat it on its own. Canned pilchards can be found in all corners of South Africa right into rural areas. The increasing expansion of South African retail chains into Africa is increasing the distribution and reach of this product in the rest of Africa (Miller 2005, 2006).

Nutritionally sardines are rich in micronutrients, vitamins and proteins (e.g. B12, vitamin D, protein, calcium, etc.). They are known to be one of the most concentrated sources of the omega-3 fatty acids, which lower triglycerides and cholesterol levels (Wolmarans, et al 2010). Direct human consumption of these small oil-rich pelagic fish (mackerels,

[19] South African sardines (S*ardinops sagax*) are caught on the west and south coast of South Africa and locally canned in six canneries. Established in the 1940s, the South African small pelagic industry, of which sardine is one of the main species, is the largest by landed volume and second to hake in terms of value (Hara and Raakjaer 2009; Hara 2013).

herrings, pilchards/sardines, anchovies) that is locally caught or imported is therefore particularly important in sub-Saharan Africa. There is no doubt in this regard that sardine is contributing greatly to food security and nutrition for the majority of South Africans especially the poor, both in rural and urban area, and increasingly in the rest of southern Africa. In a similar way Pilchard from Namibia are one of the largest fish import commodity in Democratic Republic of Congo (Franz et al. 2004).

Finally, apart from providing a valuable source of food for the poor, catching and processing of sardines provides employment and income to more than 5200 people in the fishing communities where these operations are undertaken (DAF 2012).

Interaction small / large scale fleet

Governments of Indonesia, Malaysia, Sri Lanka, India all introduced a trawling ban on their inshore fisheries (Box 3.9). One of the first one was Indonesia (Bailey 1988). In 1980 by virtue of the Presidential decree 39/1980, the Indonesian Government decided to remove one of the causes of open conflict and resource over-exploitation and damage. This political decision had two goals: resource management and development, with a direct impact on the livelihoods of small-scale fishers by a direct re-allocation and redistribution of resources away from trawl fisheries to small-scale traditional fisheries (Chong et al 1987).

The actual outcomes of these decisions have been mixed. In Malaysia, although the trawling ban was just within the five-mile limit and rezoning of fishing grounds was based on gear types in an attempt to achieve more equitable redistribution of rights to small-scale fishers, in practice noncompliance and incidence of encroachment by the large-scale vessels and even foreign operators into the prohibited fishing areas is common (Viswanthan et al 2002). Bavinck 2003's work on law and space in Sri Lanka found that enforcements of the trawling ban policy is often problematic whilst Kuperan and Sutinen (1998) call for better economic instruments to incentivize trawlers not to encroach in small-scale fisheries zones.

Overall, the interaction between small and large-scale fleets is often fuelled with conflicts over resources, fishing zones, and gear. Large-scale fleets often encroach into fishing zones demarcated for small-scale fishers, destroy their gear and impact the seabed and habitats. As pointed out by Kurien (Box 3.9) "the adverse ecological and socio-economic impacts inflicted on coastal small-scale fishing communities by large-scale trawling have led to considerable physical violence and consequently to disruption of their normal livelihood patterns resulting in income and food insecurities".

Box. 3.9[20]. Impact of large scale trawling on small scale fishing communities: Some livelihood and food security implications

[20] Box prepared by John Kurien - with contributions and suggestions by members and staff of the International Collective in Support of Fishworkers.

Large-scale trawls are massive funnel shaped fishing nets, fitted with a variety of heavy steel and wooden fixtures and ropes that are needed to keep the funnel mouth open. These trawls are towed behind powerful mechanised fishing craft called trawlers. Large-scale trawls also require considerable mechanical power to be hauled on board. Trawls can be technically characterised as ‘active’ and largely ‘non-selective’ in their operations. They are termed ‘efficient’ by some because little escapes them. Trawl nets are used to harvest fish species that inhabit the surface, mid-water or bottom layers of the sea/lake and are variously referred to as pelagic trawls; mid-water trawls or demersal trawls respectively (Nedelec and Prado 1990). Large-scale trawling entails huge capital investments, high running costs and when operated in quota management systems there are pressures to build up and maintain a track record to justify future quotas. For all this they need to fish as intensively as possible making their operations the antithesis of sustainable fishing practices (Watling and Norse, 1998).

Large-scale trawls were initially used in temperate marine ecosystems (Robert C, 2007). Trawls diffused rapidly to the tropical marine ecosystems of regions like Asia, in the early 1900s, when their effectiveness in hauling out demersal shrimp stocks from relatively shallow coastal waters was demonstrated (Morgan GR & Staples DJ, 2006). While these trawlers perennially target shrimp, in the complex, inter-species interactions of tropical ecosystems, such actions adversely affect other species that inhabit the same aquatic habitats. These species are primarily fished by small-scale fishers.

Large-scale trawl fishing, over time and presently, continues to be the major source of intense competition and conflict over both the resources and fishing space of the small-scale fishers. Large-scale trawlers also often physically destroy the small, selective fishing gear of the small-scale fishers causing considerable economic losses. Collisions with crafts of small-scale fishers are a frequent happening leading to loss of lives (Mathew, 1990). The four-fold violence -loss of access to resources and fishing space; destruction of their gear and loss of life- have an overbearing impact on the income, capital stock and lives of small-scale fishers and not just on their food security. In many countries this has also resulted in a dispossession of small-scale fishing communities from their customary relationships with the marine ecosystem. This has in turn deprived them of the way in which their cultural identity, sense of place and spiritual meaning are referenced.

Large-scale bottom trawling for shrimp did result in an increase in the overall shrimp catches. However, there is indisputable evidence that the composition of the catch shifted to the smaller and less commercially valuable species of shrimp and also to other varieties of demersal species in the form of by-catch, which may also have export markets in some cases (FAO, 2000). In the case of export-oriented shrimp fisheries, this leads to lower unit prices resulting in significant lowering of the foreign exchange earnings for the country with possible macro-economic implications for food security. Such trawling for shrimp also results in a higher share of discards compared to other types of trawling (Alverson et al, 1994; Kelleher, 2005). Today’s discards are really fishes of the future. This is loss of future food security for all. But small-scale fishing communities are particularly affected as they were originally harvesting shrimp using more passive, selective and environmentally benign fishing methods (EJF, 2003).

Large-scale pelagic trawls straddle temperate and tropical waters to harvest large shoals of small pelagic species within the EEZs of many countries. Such operations are undertaken on a perennial basis. Along with their target pelagic species, they also harvest a significant share of larger-sized fishes and other marine mammals, since the former is prey for the latter. Small-scale fishers would have caught these larger fishes using more selective and passive gears at the appropriate seasons. This again results in competition with local small-scale fishers, who are also often totally marginalised. In many quota managed fisheries these larger species are considered over-exploited and hence denied to small-scale fishers; but the ‘incidental’ catch by trawlers is often overlooked or condoned.

Large-scale trawling for pelagic species, with notable exceptions, is most often linked to supplying fish-feed for industrial aquaculture (Naylor and Burke, 2005). Using fish as feed for fattening aquaculture species such as salmon and shrimp results in nutritious, lower trophic level species such as sardines, horse mackerel, anchovy, which are the main harvest of the small-scale fishers (and often their bait for passive fishing), being over-fished. This greatly affects the livelihood, income and food security of these communities at the present and into the future (Wijkstrom, 2009).

Large-scale trawling has also been known to have adverse impacts on species such as turtles, dugongs and dolphins in coastal ecosystems where the latter species have been the source of community tourism for small-scale fishing communities (NRC, 1990; Lyle & Willcox, 2008). The disruption of livelihoods and the accompanying food security implications have been significant.

In many countries around the world, large-scale trawling has been banned or severely restricted by the state at various junctures for one or more of the reasons enumerated above. The list includes *inter alia*, Indonesia, Trinidad, Malaysia, Costa Rica, Brazil, Venezuela, Ecuador, Hong Kong and India. In these countries, the adverse ecological and socio-economic impacts inflicted on coastal small-scale fishing communities by large-scale trawling have led to considerable physical violence and consequently to disruption of their normal livelihood patterns resulting in income and food insecurities.

Large-scale trawling innately leads to greater concentration of the fish landings into large ports, often disrupting the erstwhile decentralised settlements of small-scale fishing communities. While this at one level facilitates economies of scale, at another, it results in barriers to entry to these ports for women fish sellers and processors from small-scale fishing communities who have lower financial endowments and limited access to large infrastructure and transportation facilities. The resulting loss of employment and income for women has significant adverse impact on the food security of many small-scale fishing families.

It is often pointed out that large-scale trawlers now provide more overall employment – both on board and at the up-stream processing activities. This is certainly true in many developing tropical countries. However, most often, the concerned workers are not from small-scale fishing communities. They are usually from deprived migrant and tribal communities. Recent reports from human rights groups also points to the very poor and hazardous labour, employment conditions, as well as the low incomes of these workers (EJF, 2013).

The operation of large-scale trawlers, apart from their well-documented adverse impacts on ecosystems, have very serious negative distributional impacts over overall fish harvests and employment levels in the present and into the future (Bailey, 1988; Kurien and Achari, 1990). This has adverse equity implications in the fisheries sector for small-scale fishers and other workers from an income perspective and hence affects their general livelihood and food security. Large-scale trawls, and most other forms of industrial fishing gear, are more often than not ‘over-efficient’ – extracting resources from an eco-system at a faster rate than it is replenished. They fish down the food web. Large-scale gears used by industrial fishers – especially large-scale trawls – operate in direct competition and jeopardize the livelihoods and food security of these communities (Pauly et al, 2005).

In the pyramid of fishing crafts of the globe, the small numbers of large-scale trawlers occupy the apex. But it is the hundreds of thousands of small-scale fishing crafts at the base which provide for its stability (FAO, 2012). However, the financial and political clout which these two sets of crafts exercise globally can only be represented as an inverted pyramid and exhibits the entrenched hierarchy of power and class relations that exists within the fisheries sector. Small scale fisheries/ fishers are the lowest, least empowered section.

Large scale fishing gears, especially trawls, continue to have a negative impact on small scale fisheries because of their position in the "pecking order". Despite their smaller numbers, they are more powerful politically, economically, and with more power to influence decisions in their favour. They have more physical power to access fishing grounds and to extract resources. They also have more economic power and socio-political influence in the fisheries sector.

There is a case here to urge and actively support small-scale fishers globally to continue fostering gear diversity, using gears which are mostly environmentally benign, mesh with the rhythms of nature in their specific fishing sites, and keep within the regenerative capacity of the ecosystems in which they operate. This is perhaps the only way they can be motivated to unite and oppose the technologies and also the economic and political systems which jeopardise their livelihoods, food security and the ecological integrity of the aquatic resources and ecosystems.

Aquaculture

In aquaculture the current discussion is heading in a different direction to that in capture fisheries. Aquaculture has long been championed by development institutions based on the activity's perceived potential to alleviate poverty, enhance food security and promote economic development (Muir 1999). Forms of aquaculture considered 'small-scale' have received particular attention in this regard; both in Asia (Friend and Funge Smith 2002; De Silva and Davy 2009) and in Africa (Harrison 1994; Jamu and Brummett 2004). However, the failure of the sector (in particular in Africa) to build on the five decades of donor-driven pilot projects approach has led to some recent change in the paradigm. In particular the conventional wisdom that direct participation in aquaculture by low-income producers should provide greater potential to alleviate poverty and contribute to food security is increasingly being questioned (Brummett et al., 2008). Beveridge and colleagues for instance conclude in the case of Africa that:

> "The relative poor performance of African aquaculture has been caused by a number of factors, among them the different market conditions in Africa, but also the externally driven focus on smallholder aquaculture. Whilst this has proven successful in building resilience of poor smallholder farmers to external shocks through improving household nutrition, building social capital (through exchange of fish within communities) and reducing sensibility to periodic drought, it had not led to significant growth in production at national or continental level. Rather, current evidence indicate that significant increases in farmed fish production in Africa are more likely to be achieved through careful investment in well targeted value chain approaches to the development of the SME [small and medium enterprises] aquaculture sector in place where this can respond to strong markets (…)" (2010, p. 355) .

As a consequence, a growing number of studies and discussion papers on aquaculture in sub-Saharan Africa now increasingly advocates for the re-alignment to investing in medium-size entrepreneurs where fewer people are employed yet greater impact on the national and regional levels of food security is achieved. Interestingly Dey et al (2010) or Belton et al (2012)'s work in Asia came to a similar conclusion, namely that more commercial-oriented medium size fish farmers may actually be better equipped to achieve economic success and address the food security question at the national level.

Reflections from agriculture and final remarks

An interesting parallel can be draw between this discussion on scale in fisheries and aquaculture, and what is currently debated in other sectors –and in particular in agriculture-, in relation to food security. As highlighted by the HLPE report on 'Investing in Small-holders for food security' two narratives are often found in the agriculture literature (HLPE, 2013, p.20): on one hand, similar to the narrative that presents 'small-scale fishers as the poorest of the poor', the first narrative assert that [farming] "smallholders will never be competitive" - they are poor, vulnerable and marginalized. Eventually, as part of a 'natural' modernization process they will be replaced by larger farms that are actively engaged in the global market and agro-food industries. Only few of the smallholders will be entrepreneurial and the majority will disappear.

On the other end of the spectrum a counter-narrative proposes a different vision. It argues that smallholders should be supported to become "modern peasants" who can be productive, efficient and resilient. These modern peasants will provide high quality goods for the local and regional markets, and for the growing cities; they can promote sustainable agriculture through protecting the natural resources and can limit their use of fossil fuel and agro-chemicals.

The reality, of course, is more complex and less clear-cut. While in some instances, success stories can be identified, these are still the exception rather than the rule. A large number of smallholders in developing countries are currently confronted by the structural agricultural reform that is shaped and driven by global market forces, and agro-food industries and a large majority of smallholders are struggling to cope with unequal access to domestic markets, or with unfair conditions to the access of the productive assets, characterized by huge market failures' (HLPE, 2013, p.20).

What do these reflections mean for fisheries and aquaculture? Clearly it seems that some parallel can be drawn between agriculture and aquaculture. Perhaps this observation should not come as a surprise. After all, aquaculture is certainly closer to agriculture than it is to fisheries. Smallholders in agriculture such as medium scale aquaculture enterprises can contribute to food security and to show impressive productivity. For this to happen however, a certain degree (even minimum) of commercialisation is necessary.

The case of fisheries seems different, possibly because of the original labour buffer function of the small-scale fishery sector in developing countries. Quite a significant number of these small-scale fishers or fish traders are still landless, and for them fisheries do provide an important alternative to agriculture to support their livelihoods in the absence of better opportunity elsewhere.

Ultimately, if the goal is to provide food security and nutrition through fisheries and aquaculture, it seems that scale is indeed a critical factor to consider. As shown above, small-scale fisheries seem to be better equipped than larger-scale fisheries in general to contribute more adequately to food security with regard to availability, accessibility, affordability to the poor, marginal and vulnerable coastal communities and local populations. Hence, there is no doubt that small-scale operators in the fisheries and related activities (fish processing and fish trading) should be prioritized by policy makers. Interestingly this is also the conclusion that was reached in Section 3.6 on 'Producers versus consumers'. However, as the discussion above showed, large-scale fisheries can also in certain very specific circumstances play a significant role in supporting food security and nutrition in developing countries, when their activity is oriented towards the production and commercialisation of cheap, easily stored and transported (e.g. canned) fish for local or regional markets. The example of the South African pilchard was illustrative in this respect. The fact that these small pelagic (mackerel, sardines, pilchards, anchovy) are particularly nutrient-rich fish adds to the argument. In conclusion policy makers should support investments in small-pelagic activities for human consumption, especially in sub-Saharan Africa.

For aquaculture, the conclusions are not so clear. The small-scale, subsistence aquaculture model has failed to deliver its promises in terms of poverty alleviation and food security, and the paradigm has now shifted toward slightly larger (i.e. medium-scale), more commercial-oriented enterprises, with the hope that this new emphasis on medium scale will be more successful at delivering benefits. Time will tell whether this was the right strategy.

4. Gender, food security and nutrition

Food and nutrition insecurity are outcomes arising from inequalities, including those related to gender. In the fisheries literature, "gender" and "gender and development" papers focus mainly on women, ignoring that men's conditions and behaviour are also critical in social and gender relations and that men can also suffer from food and nutrition insecurity because of gendered fish sector work.

The mention of gender in a fisheries context evokes typically themes of the gendered divisions of fisheries labour, women's roles in productive and reproductive spheres, women's agency in the sector and women in fisheries and aquaculture institutions (Harper, et al 2013, Williams et al 2013). Deeper analyses are emerging, however, revealing the dynamics of gender issues of significance to food security and nutrition, such as the importance of the intersections between gender and social factors such as culture, economic class, religion and social status ("intersectionalities") and the gendered impacts of the massive sectoral change such as modernisation, mechanisation, market concentration and labour cost squeezes. In keeping with the distinctions made in this report, we distinguish between the relevance of gender to fish and FSN for (a) people in the general population, and (b) those within fish supply chains –who are more directly affected.

4.1 General Population: Gender, Fish, Food Security and Nutrition

In the general population, gender is important in at least two ways: nutrition and access to fish.

Gendered aspects of the role of fish in food security and nutrition include when balancing the benefits of eating fish by gestating women on foetal development and for children on childhood brain development and the risks of damage from dioxin and methylmercury contamination. In 2010, FAO and WHO (FAO/WHO 2010) reviewed these risks and benefits and concluded that overall fish provide people with energy, protein and a range of other important nutrients, including the long-chain n-3 polyunsaturated fatty acids (LCn3PUFAs). With regard to maternal and childhood fish consumption, the report recognized that, in most studies, the benefits of LCn3PUFAs outweighed the risks of methylmercury to women of childbearing age such that maternal fish consumption lowers the risk of suboptimal neurodevelopment in offspring compared with the offspring of women not eating fish (FAO/WHO 2010)[21].

Although not studied in the general population, intra-household differences in access to fish as food is likely to differ by gender because fish is often higher priced than other food, more volatile in price and seasonally scarce. In times of scarcity, the whole household may lose access to fish, but women are likely to be the more severely affected due to their relatively subordinate positions in most societies, their lower incomes and control of household funds (Maxwell and Smith 1992, Quisumbing et al 1995).

During times of crisis and disaster, and depending on the nature and location of the crisis, women and men experience different risks and opportunities during and after, including access to food and relief services (Module 11 Gender and Crises: Implications for Agriculture, World Bank et al 2009). Specific information on the role of fish in these circumstances is not available. Due to its price and the perishable nature of many fish

[21] As long as maternal exposure to dioxins (from fish and other dietary sources) does not exceed the provisional tolerable monthly intake (PTMI) of 70 pg/kg body weight, neurodevelopmental risk for the foetus is negligible. At levels of maternal exposure to dioxins (from fish and other dietary sources) that exceed the PTMI, neurodevelopmental risk for the foetus may "no longer be negligible." For infants, young children and adolescents, insufficient data are available to assess the health risks and health benefits of eating fish (FOA/WHO 2010, p.x)

products, fish typically are not part of the food supplies used in disaster or famine relief. The World Food Program (2013) recommends including animal protein in famine relief diets but milk-based ingredients rather than fish or meat are given in sample formulated foods. The World Food Programme guidelines emphasize the importance of nutritional deficiencies experienced by lactating women (e.g., iron, Vitamin A, fatty acids) but do not address the role that fish could play.

4.2 Fish Linked Communities: Gender, Fish, Food Security and Nutrition

Within the population group that is the main subject of this report (those people and households directly linked into the fish production and supply chains), gender has a central role in the elements that determine food and nutrition security – availability, access, stability and utilisation and nutrition adequacy. Gender, along with intersectional factors such as economic class, ethnic group, age, religion, etc, influence FNS in myriad ways. Five priority ways are explored: the gendered patterns of fish sector work, gender blindness in fish sector policy, gender within the household, gendered change within the sector, and intersectional issues.

Gender and Work in the Fish Sector

The work that people do and how it is rewarded has a major impact on their own food security and that of those around them. Thus, to better understand the gender patterns of work, we examine gender disaggregated data that highlight that women tend to be found in lower-paid positions. However, the lack of regular labour statistics and information on some men-only jobs, such as contract fishing labour, prevent a better understanding of certain gender issues.

Most work in fisheries and aquaculture is highly differentiated by gender. Women work in nearly every type of fish sector work but their typical positions are much less visible than those of men, often leading to the perception that fisheries and aquaculture are men's domains both in developed and developing countries (Davis and Nadel-Klein 1992; Bennett 2005; Williams et al. 2004). Men are dominant in the fisheries and aquaculture direct production work. Much of women's work, such as gleaning, diving, post-harvest processing and vending, is not recognized or is poorly recorded, despite its economic and other contributions (Weeratunge et al 2010). In many countries, women cannot register as fishers and so are outside the systems of sector support and capacity development. However, the recent shift to taking a whole-of-supply-chain approach means that the gender dimension in fisheries is now more obvious as more women workers are counted (Dey de Pryck 2013).

The first comprehensive attempt to estimate the number of fishworkers found that half of the 120 million people who work in the capture fisheries sector and its supply chains, (56 million or 47%) are women (World Bank/FAO/WorldFish 2012). The vast majority of these work in association with small scale fisheries in developing countries and thus many are likely to be at risk of food insecurity (Table 8.1). Post-harvest workers (84 million), many of whom are women, outnumber the harvest workers (35 million). In small-scale inland fisheries and large-scale marine fisheries, women outnumber men, in the latter case due to the number of women working in processing (Table 4.1). However, small scale fisheries and supply-chain jobs outside production are the most poorly recorded, so actual percentage of women may be even higher.

Table 4.1: Global Capture Fisheries Employment by Gender (World Bank et al 2012).

	Small-Scale Fisheries			Large-Scale Fisheries			Total
	Marine	Inland	Total	Marine	Inland	Total	
Number of fishers (millions)	13	18	31	2	1	3	34
Number of post-harvest jobs (millions)	37	38	75	7	0.5	7.5	82.5
Total	50	56	106	9	1.5	10.5	116.5
% Women	36	54	46	66	28	62	47

Women's participation varies greatly from country to country, e.g., over 70% in Nigeria and India, and 5% or less in Bangladesh and Mozambique (Table 4.2, World Bank 2012).

Table 4.2 Women in Fisheries Workforce in Developing Countries (Source: World Bank 2012, Table 3.12

Country/Case Study	Total Workforce ('000s)	Percentage
Nigeria	6,500	73%
India	10,316	72%
Cambodia	1,624	57%
Ghana	372	40%
Senegal	129	32%
Brazil	493	30%
China	12,078	19%
Bangladesh	3,253	5%
Mozambique	265	4%

Comparable estimates are not yet available for the 30 million aquaculture sector workers. However, the FAO National Aquaculture Sector Overview Fact Sheets show that women's participation varies by country and type and scale of enterprise, e.g., typically being more active in small-scale operations, hatcheries and post-harvest processing (Williams et al 2012b). However, less information is available on gender in aquaculture compared to that on gender in fisheries.

As in most economies subject to increasing globalization, women's income in fisheries and aquaculture is usually lower than that of men, at least partly because women are locked into less influential and remunerative work (Neis et al 2005). Even where women are in the majority, such as in processing factories, few rise to the supervisor and management levels. In a study of 10 factories in Sri Lanka, de Silva and Yamao (2006) found that those who did rise were either better educated than their male peers or were wives of top managers.

Gender-blindness in Fish Sector Policy and Practice

Gender disaggregated data are not routinely collected and, partly as a result of this, little policy attention is given to the gender dimension in the fish sector. All major recent normative instruments, starting with the Code of Conduct for Responsible Fisheries, have been gender-blind (Williams et al 2012a), thus effectively obviating substantive attention to gender in development policies and programs at global and national levels. Women's sectoral needs tend to have been ignored as sectoral development assistance was channelled to men in efforts to mechanize and modernize fishing and aquaculture; general gender/women's programs focused on women's basic needs, e.g., as described for Pacific island fisheries by Ram-Bidesi (2008).

In the last 30 years, periodic efforts have been made to initiate global fish sector policy and practice on women/gender but most were not sustained beyond the timeframes of the projects under which they were initiated. These efforts often focused directly on gender and FSN, e.g., the Sustainable Fisheries Livelihood Programme (FAO 2007), and the Regional Fisheries Livelihood Programme (Lentisco and Alonso (2012). In 2011, FAO conducted a workshop (FAO 2012) to help develop the way forward and are currently engaged in internal follow-up. For the first time, gender was highlighted as a special theme in the 2012 FAO State of World Fisheries and Aquaculture (FAO 2012).

Another consequence of gender-blindness in the fish sector is that little has been invested in research for development to help understand the problems of gender inequality and how to address them. What is invested in gender research mainly focuses on women, with very few studies examining the relevance of masculine behaviour (Allison 2013), gender relations and their impacts on food and nutrition security.

Development projects incorporating gender have tended to focus on narrow economic empowerment approaches. The support is directed at giving women income earning opportunities but often it ignores deeper social and cultural factors. Choo and Williams (in review) reviewed 20 studies reported over five gender and fisheries symposia dating from 1998 and found that many projects ignored critical systemic power factors. Some development interventions merely overburdened women with additional work. To move up the empowerment ladder, women needed legitimate access and secure rights to space and resources, plus training, professional recognition and visibility. Culture tended to either support or limit women's empowerment but few interventions sought to change it. Most importantly, empowerment takes time and fisheries development agencies often have to undergo deep organizational change in order to address gender adequately (Debashish et al 2001, Nozawa 2001).

Gendered Arrangements within the Household

Cultures and local practices create an infinite set of variations of the theme of households (Porter 2012). Households rarely operate as single units and often do not keep common accounts. From their accounts, women are more likely to feed, clothe and educate children and dependent family members (Quisumbing et al 1995, Porter 2012). In polygamous societies and others where multiple partners occur, household economies are webs of asset and income controls and the relations among the partners are complex. When resources and assets are scarce, the negotiated use of income and assets can be critical to survival. Porter (2012) examined these issues in a Muslim coastal fishing community in Tanzania in which women used and negotiated their scarce resources to support their own separate households and, at times, those of a shared husband/partner.

These intra-household complexities have important consequences under the fish sector development strategy of directing assistance to male-dominated activities such as new fishing and fish farming technologies. Such assistance may have had little impact on household food security as it directed most of the help to the men and not to the women who were more likely to give greater priority to food security.

Women, whether in male-headed or female-headed households have, on average, less access to productive assets and manage smaller assets, leading to much lower productivity than in the case of men (FAO 2011, Weeratunge et al 2012). Female headed households tend to be significantly poorer and hence more likely to suffer food insecurity than male headed households. For example, in a Cambodian study of over 5,000 fishing livelihood dependent households, Ahmed et al (1998) found that literacy levels were higher for male (85%) compared to female heads (57%) and female headed households lagged behind those of male headed households on economic activity, numbers of children in school and housing standards.

Gendered change

The fish sector has undergone rapid structural, economic and resource change and continues to evolve. Most drivers of change, whether internally or externally driven, is gender neutral but result in highly gendered outcomes.

Fisheries and aquaculture have become increasingly masculinised with the introduction of new technologies and the growth in scale of operations, even of small scale fleets and fish farms. Claims that many new jobs have been created for women have often proven, on balance, weakly founded. For example, women lost much of their traditional fish processing work in Gujarat (India) when industrial fishing and processing took over. Cheap migrant women were recruited from Kerala and Kanyakumari for the factories, rather than using the local women (Nayak 2007).

The declines of fishery resources are causing several kinds of gendered change. The most vulnerable households are usually those in which women and men both participate in work in the fishery, e.g., in the Pantar islands, Indonesia (Fitriana and Stacey 2012). Women can become less visible but their social support more critical. Domestic violence, usually undocumented, seems to be more prevalent and, due to the social stigma, often handled privately. The repercussions of this for household food security are not documented. Men displaced by fishery crises often move into overlapping work and social spaces with women, such as Turgo (2012) described in the fish market space in a Philippine town.

Even women's success with new technologies can lead to changes that impede their long term success. In India, aquaculture enterprises experienced gender bias in the rights to coastal space (Ramachandran 2012). In southern India, mussel farming on the Malabar coast initially took off as a women's aquaculture industry and "empowerment platform" supported by the Self Help Group movement of Indian government agencies and NGOs (Kripa and Surendranathan 2008). However, as mussel farming became successful and profitable, men began to move into the industry and the women's groups could not legally protect their use rights to the mussel farming grounds. Meanwhile, open sea cage culture, requiring larger capital to start up, was developed by men and their rights to cage sites were protected by the State from the start.

Intersectional issues

In the fish supply chain, gender is just one of the key human dimensions that can affect food security. It intersects with class, age, religion, migrant status and other factors, creating combinations of factors that can influence the chances of some groups becoming food insecure. FSN risks are not limited to women in small scale operations, but occur for women and men even on industrial scale vessels and in onshore processing factories. These employ many poor people, often contracted immigrant workers earning meagre incomes and working under difficult conditions. Most immigrant labour is low-paid and hence implies a food security risk. This can be compounded by hazardous working conditions.

A preliminary study of transnational organized crime in the fishing industry postulated that the decline of coastal fish stocks and the consequent food insecurity of dependent communities was a factor in providing men and youths as forced labour on fishing vessels (de Coning 2011). The study found that the male victims of human trafficking became forced labour for "fishing vessels, rafts or fishing platforms, in port, or in fish processing plants." Food and nutrition security may not be assured for the workers, and little is known about the food security situation for those left at home.

Women and children could be forced into prostitution at ports and in processing plants. Even if not trafficked, women are reported to be at risk of sexual exploitation in some processing plants (Nishchith 2001). Women and men often work in processing plants under conditions hazardous to their health; women may be more affected than men (Jeebhay et al 2004).

In addition to human trafficking and forced labour, immigrant contract labour (women, men and children) is an increasing part of national fish industries, e.g., in Thailand, 75% of male laborers on Thai fishing vessels are Burmese and Cambodians, and the remainder are Thai nationals (Chokesangan et al. 2009).

Age also is an important intersectional factor. Even girls and boys (under age 18 years) labour in large numbers in fisheries to secure their own and their families' food security (FAO and ILO 2013). From limited data available (Allison et al 2011), the majority of child workers are boys. Often the work is hazardous but almost invariably it brings life-long detriment to the children as it limits their opportunities for access to regular education and later work opportunities and social advancement – all factors contributing indirectly to food insecurity.

4.3. Summing up the FSN Implications of Gender

Gender differences and inequalities have important impacts on food and nutrition security outcomes in the general population and in communities directly linked to the fish supply chain. For the general population, women and their progeny can benefit from eating fish, but the poor, and especially poor women, will often have less access to fish because it is priced out of their range.

Within the communities linked to fish supply chains, food security often has a gender dimension from unequal work opportunities, remuneration and hazards, gendered change that shifts the opportunities and risks and intersectional factors, such as age, economic and migrant status, and that affect the youth and men as well as women, and which occur in large scale and industrial operations as well as in small scale fishing and fish farming.

5. Governance, food security and nutrition

5.1 Why is governance key to food security?

In the context of natural resources, governance refers to "the ways power and decision-making over natural resources are distributed and exercised amongst stakeholders" (Béné et al, 2009, p. 1938). Governance consideration is therefore particularly relevant to the question of how the benefits from fish are distributed, including what priority is given to people who lack FSN to share in the benefits and to what extent. Governance arrangements are part of the key institutional mechanisms which will influence the ways diverse individuals and groups (in our case primarily poorer and marginalized people in the fisheries and aquaculture supply chains) will gain (or lose or be excluded from) access to fish resources and to other productive supply chain assets. For people in different occupations or linked into different parts of the supply chains, different elements of governance, involving different legal provisions, policies, administering agencies and industry/community associations lead to very different outcomes.

The chief overarching global legal, soft law and policies affecting fish and food security include the Human Rights Convention, the UN Convention on the Law of the Sea, the Convention Against all forms of Discrimination against Women, the Code of Conduct for Responsible Fisheries, the various UN environment instruments, especially the Johannesburg International Plan of Implementation and the Millennium Development Goals, plus labour and human health instruments. Other international instruments and commitments, such as the Voluntary Guidelines on Responsible Governance of Tenure of Land, Fisheries and Forests in the Contexts of National Food Security (Tenure Guidelines) and the Voluntary Guidelines on the Progressive Realization of the Right to Adequate Food in the Context of National Food Security (Right to Food Guidelines) complements them to ensure the important role of small-scale fisheries in food security. To various extents, these instruments are adopted, adapted and implemented through national laws, policies and programs.

Here, we focus on fisheries and aquaculture governance and their impacts on FSN. Governance and management in other segments of the fish supply chain fall more within the remits of private sector and social welfare laws and agencies, and certain aspects are dealt with in the gender chapter.

5.2 Fisheries governance

Fisheries are common pool resources and their governance contains the challenges and opportunities peculiar to commons, plus additional complexities due to difficulties to see, monitor and control. As Grafton et al (2010) noted: “common property and customary management institutions are not always resilient to the expansion of market forces, technical change, and integration into modern states and forms of property.” This is at the heart of the challenges for FSN in fisheries.

Impacts of co-management reforms on food security

In the international regimes exemplified by the United Nations Law of the Sea and similar global instruments, fisheries management responsibility rests with the nation State and formal matters regarding fisheries emanate from the State powers. In most developing countries, modern fisheries regimes and powers began during the colonial regimes and were then taken up in the structures of the independent States, using the paradigm for fisheries governance that consisted of a system where decisions about fisheries management (who can fish, where, when and how) were made centrally by the government (generally through the department of fisheries under the ministry of agriculture). Typically, fisheries management objectives were dominated by sustainable yields and economic development. Indeed, small scale fisheries were often forced out or into violent conflict with the incoming industrial trawl, purse seine and gillnet fleets, e.g., as described for Southeast Asia in Butcher (1994) -see Box 3.9).

Yet, although industrial fleets flourished, small scale fisheries persisted and also grew in numbers. The persistence of a multiplicity of scales of operators was one reason, but only one, for, in the last 30 years, a shift from the central management approach to a range of systems generally referred to as ‘co-management’ where power and management responsibilities are now explicitly decentralized/devolved and shared to various degrees with a range of different stakeholders (local governments, fisheries cooperatives or associations, fishing communities) (Jentoft et al 2010). In reality, much local fisheries governance in developing countries was carried out within the domain of customary regimes with a wide range of authority, rights, rules, monitoring, accountability, and enforcement (e.g., Ruddle 1994). Colonial powers, religious conversions, independence and post-independence policy making tended to overlay governance arrangements rather than wipe the slate clean and replace it with the new regimes (Adhuri 2013).

The hybrid paradigm of co-management in fisheries can be defined as

> “a partnership arrangement in which government, the community of local resource users (fishers), external agents (non-governmental organizations, academic and research institutions), and other fisheries and coastal resource stakeholders (boat owners, fish traders, money lenders, tourism establishments, etc.) share the responsibility and authority for decision making over the management of a fishery” (Pomeroy 2001, p.113).

The consensus in favour of fisheries decentralization – either under co-management or even community-based natural resource management (CBRM)[22] – has now been accepted as the prevailing orthodoxy in the majority of developed countries, and also in an increasing number of developing countries, in Africa (e.g. Uganda, Mali, Malawi, Mozambique, Senegal, Ghana), in Southeast Asia (e.g. Philippines, Indonesia, Vietnam), and in other parts of the world (e.g. the Fiji Islands) –initially as a result of donors’ pressure, but more recently as a result of ‘genuine’ buy-in from these countries, and often with location-specific support from environmental and development non-profit agencies. The approach, involving greater participation from local and grassroots bodies, is also enshrined in some of the principles of the Code of Conduct for Responsible Fisheries and, more so, in the Ecosystem Approach to Fisheries/Aquaculture (FAO 2003, FAO 2010).

The justification of co-management in fisheries had initially been made on the basis of

[22] In community based fisheries management (CBFM) local users groups, either formally or informally, have the rights and responsibilities for managing their own resources. They may use different traditional or more formal means for defining access rights, fishing methods and fishing limits. It can engage the local community in fisheries management, and is considered particularly effective where government capacity and resources to manage fisheries are limited.

managerial efficiency (to reduce implementation costs and improve compliance in a sector where the government's agencies are notoriously lacking capacities and resources – e.g. DAFF 2011) and on consideration of resource conservation (by including end-users in the management process, co-management is expected to make these end-users more responsible, thus leading— in principle—to more responsible and sound exploitation of the resources) (Pomeroy 1995; 2001; Jentoft et al 2010).

Co-management is, however, also increasingly considered as a more ''democratic governance system" (Nielsen et al., 2004, p. 154), as it implies the increased involvement of end-users and the delegation of responsibilities to be brought as close as possible to these users. It is also seen as the feasible form of management when governments lack necessary resources, but among the critical institutional issues is who gets a seat at the table (Pomeroy et al. 2001; Jentoft et al 2010).

As such co-management in fisheries has progressively been associated with poverty reduction, pro-poor policy, and empowerment (Berkes 1995; 2009) -even if these agendas were initially totally absent from the foundation arguments (Béné and Neiland 2004) and have not been empirically measured and demonstrated in practice (Evans et al 2011). To the present, fisheries co-management reforms contributes to the current narrative that presents decentralization in natural resources as an important way to ensure poverty reduction, especially in rural areas:

> "Decentralizations in natural resources [are seen as reshaping] profoundly the institutions on which the local management depends, therefore affecting greatly who manages, uses, and benefits from these natural resources. As rural poor are those who rely more heavily on natural resources to sustain their livelihoods, the potential role of decentralization reforms in natural resource management can be remarkably effective (or in contrary especially armful) for the poor." (Béné et al. 2009, p.1936).

Therefore, although food security and nutrition are not explicitly included in the 'logic' of the discourse, co-management reform is in theory expected to improve access to the resources and the status of the resource itself –thus possibly boosting the incomes of these who depend on this resource for their livelihood. As such the implementation of co-management is expected to impact positively on the food security and nutrition of the beneficiaries of these reforms.

The reality is not so clear-cut, however. While in Asia assessments indicate that co-management reforms seem to have had globally positive impact, a large part of this positive story seems to be specifically attached to one country (the Philippines). A recent meta-analysis covering the major developing countries regions found that when this country is removed from the analysis, co-management does not seem to have any clear effect on household income (Evans et al. 2011, p.1945). While some cases show positive effects, others suggest that this increase in incomes cannot systematically be attributed to co-management. Instead these higher incomes often emerge from complementary project activities, such as introducing microcredits or providing skills training related to alternative income earning opportunities (unrelated to fishing) or from completely independent trends such as migration and remittances. In term of resource status and the effect that co-management is expected to have on that status, again the meta-analysis shows mixed results. Without the Philippines, data suggests an improvement of the resource-base, but the changes are non-significant for the large majority of the cases (Evans et al. 2011, p.1945). Finally in terms of access to the resource, data shows both positive and negative perceptions from end-users, with however a slightly larger number of negative cases.

In sum, both in terms of a direct pathway to food security through access to and improved status of the resource-base, and an indirect pathway through income derived from fishing related activities, the effect of co-management is not necessarily as positive as one could have expected. This is a disappointing finding, which is however in line with other recent reviews. In Africa an evaluation of 5 countries' inland co-management experience found that the outcomes of these decentralizations have not been systematically positive either. In most cases, fisheries co-management failed to improve governance, but simply altered the distribution of power and responsibility amongst the different stakeholders. In this new political landscape, poorly designed reforms have enabled a variety of (usual and new) local actors to advance their own agendas, often at the detriment of the direct end-users (i.e. the fisherfolk) (Béné et al. 2009).

In their review of customary marine management and its effect on sustaining resources, Cinner and Aswani (2008) found that this management was effective when population was low, far from markets, and people were relatively equal in economic terms. Close to markets, customary management tended to break down. When a local species became highly sought after by the market, no matter how distant, local individuals and communities frequently used customary institutions to manage or exclude outsiders without moderating their own use. Although the review did not address FSN directly, one may infer that the FSN implications of the use of customary and community based management were not very positive.

In meta-analysis of the linkages between coral reef fisheries and social and economic factors, Cinner et al (2009) detected a u-shaped relationship between coral reef fish abundance and economic development index – reefs in locations with intermediate levels of development had biomass estimates of about a quarter of those at locations with either low and high development.

Overall the ability of the scientific community to 'demonstrate' rigorously the impact (positive or negative) of governance reforms on the food security and nutrition of the end-users is poor. In their recent assessment of evidence Arthur and his colleagues conclude in their governance section by recognizing:

> "Yet the literature remains weak in its ability to extrapolate beyond the individual case

> without 'cherry-picking'. There is also currently no single consistent framework proposed to assess how well fisheries governance systems are performing (including for the poor) or to identify how these systems can be improved. Overall issues of knowledge and power and how these have become established are highlighted although there is little systematic evidence in the current fisheries literature of how these affect poverty outcomes." (Arthur et al. 2013, p.5)

Fisheries governance at the international level

Governance –and governance reforms- are also taking place at the international level. Section 3.4 above highlighted that the prevailing discourse at that international level is one of a "world fisheries in crisis". Partially contributing to this vision, but also feeding from it, a powerful narrative has emerged in the last decade, symbolized by the World Bank/FAO report "the Sunken Billion - Economic Justification for Fisheries Reform" (World Bank-FAO 2009)[23]. This narrative calls for a substantial reform of the world fisheries, and can be summarized as follows: we are currently dissipating billion of dollars every year and putting the world fisheries in great danger by letting too many fishers operate. We need to work together to curb this irrational 'race-for-fish', and put in place the right management system that helps rationalize the world fisheries, reduce the overall number of fishers and tackle Illegal Unreported and Unregulated (IUU) fishing. If we are successful in implementing this reform, we would then be able to maximize the rent extracted from fisheries resources (as it is already done in few countries –e.g. Norway, New Zealand, Australia), and could use this rent to lift people out of poverty.

This narrative is attractive, and has therefore found support from a very large number of international institutions and organizations, including the World Bank, the OECD, the FAO, and a large part of the fishery academic community. Important funds have been invested to lobby for the 'fisheries reform' through various programmes –e.g. the Global Partnership for Ocean (GPO), the WorldBank PROFISH and its sub-programmes (e.g. WARFP in West Africa, CRSD in Vietnam, etc.), the NEPAD-PAF and its sub-programme (e.g. CAFRS), and various documents and reports (e.g. Sutinen 2008; World Bank and FAO 2009; Leal 2010). Some of these programmes are already operating in Africa and Asia with the help and support of the World Bank, but without the consultation or the representation of the direct 'beneficiaries', namely the millions of women and men engaged in small-scale fisheries-related activities in developing countries.

In these conditions, the key governance challenge is not to find the 'right' governance reform which would enable governments of developing countries to move their small-scale fisheries sector closer to a rent extraction industry. The challenge is to improve the

[23] Mainly relying on the results of "The Rent Drain" PROFISH funded initiative (Kelleher, K. and Willmann, R. (2006)), this 2009 World Bank-FAO report proposes to estimate the amount of rent that is currently lost at the global (world) level due to overfishing. The report concludes that approximately US$50 billion per year were lost, representing "the difference between the potential and actual net economic benefits from global marine fisheries" (World Bank-FAO 2009, p.xiii).

transparency and representativity of these international programmes in order to get the 'right' decisions related to the FSN of these millions of end-users. To date, the rationale for these programs has done little more than pay superficial attention to the complex links between fish and food security.

Another indicator of the implicit exclusion of small-scale fishers from the debate is the discourse around Illegal, Unreported and Unregulated (IUU) fishing. In this debate the focus is on FAO 'International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU)' and the legally binding 2009 'Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated fishing'. Currently, the role of Interpol and the Global Ocean Commission all focus their attention on the international responsibilities by Flag States, Coastal States and Port States. Nothing is actually made to link these IUU fishing issues to small-scale fisheries. Instead, through their narrative, the international organizations advocating for the fight against IUU, which is directed more towards the large scale industrial fleets, indirectly contribute to the construction of the view where all fishers are perceived as 'roving bandits and outlaws'. Yet, while illegal activities are certainly taking place, a more plausible alternative assumption is that the vast majority of the 110+ million people who work in fish supply chains are members of households who are simply trying to make a living.

The IUU term does not make a clear distinction between what is illegal and what is unreported and unregulated. The problem is that experts estimate that more than 70% of what small-scale fishers catch in developing countries is actually unreported and (possibly) unregulated fish –due essentially to the lack of appropriate monitoring systems. In that context, the absence of clear conceptual and/or empirical distinction between the three components of the IUU is specifically harmful to the small-scale fishers, while the initial argument/motivation for this concept was to actually target the large-scale industrial boats that were acting illegally. The link to food security is obvious and has already been raised at the highest level. In his Note to the Secretary-General of the United Nations, the Special Rapporteur on Right to Food noted about the IUU initiative:

> "this is unclear whether these efforts are well guided. (…)[W]hile illegal, unreported and unregulated industrial fishing is a problem, most of the catch of small-scale fishers goes unreported. Analogizing these catches to illegal fishing underestimates their role in contributing to food security and does not encourage the fishers concerned to shift to more responsible practices." (point 49 p.18:)

The case of the Code of Conduct for Responsible Fisheries

The Code of Conduct for Responsible Fisheries (CCRF) has been the principal global instrument guiding fisheries (and aquaculture) developments since it was adopted in 1995. A non-binding instrument, it has since been further developed through the addition of 41 derivative documents comprising technical guidelines, international plans of action, etc (FAO 2012). The illegal elements of fishing are dealt with in several of the Code instruments, most recently and importantly in the binding Port State Measures Agreement.

More generally, the CCRF acknowledged the importance of small scale fisheries but not until 2004 did it start to seriously address the needs of small-scale fisheries. A new normative instrument on SSF is now under development, taking a highly participatory, broad-based consultative process. Overall, however, the 2012 Evaluation (FAO 2012) found that the "Code pays very little attention to either food security or poverty and mentions them [small-scale fisheries] only in passing." The themes were not elaborated further in Code instruments which have more of a focus on environmental sustainability and technical issues related to aquatic resources rather than on the people who depend on them. In scoring the 41 instruments, social inclusion and gender mainstreaming obtained the lowest scores. The Evaluation recommended, among others, that FAO should ensure that developmental objectives such as gender equality, food security and poverty reduction become the primary drivers of its work, across all types of fisheries and aquaculture.

Although emerging after the CCRF, the ecosystem approach to fisheries (EAF) and the ecosystem approach to aquaculture (EAA) were developed as vehicles for implementing the Code. The FAO evaluation found strong demand from fishery stakeholders for guidance on EAF/EAA, but slow practical development and actual uptake of the approaches. Further, and of most relevance to FSN, development of the social and economic elements of the EAF/EAA lagged behind that of the biological and environmental.

5.3 Governance issue in aquaculture and links to food security

Like in fisheries, one could very rapidly identify areas in aquaculture where the lack of appropriate governance mechanisms may affect the ability of fish-farmers –in particular the small-scale farmers- to operate in a supportive environment, with potential implication for their food security. In addition to the CCRF and its aquaculture-relevant instruments, the generalized use of the Best Management Practices (BMPs) approach as a way forward to address some of the aquaculture sector limitations and in particular the impacts that uncontrolled development of fish-farming may have on the environment (See section 3.4) has been relatively successful in reducing the risk of these environmental impacts (Hishamunda et al 2012). But these BMPs are not necessarily scale-neutral. Because they often lack the necessary awareness, organisational capacity and marketing skills to participate in these BMPs programmes (which are increasingly associated with certification schemes), small-scale producers may end up excluded (or even exclude themselves) from these schemes (Bush et al. 2013). In that context it is not a surprise that large or well-connected farmers have been systematically observed to benefit more from the BMP approach than smaller operators -although successful cases of clusters of farmers in BMP schemes offer one way forward for small scale operators (Umesh et al 2009).

In the last 10 years, BMPs have been promoted and supported by a wide range of ‘external’ stakeholders, including industry bodies, development agencies and international NGOs but also scientists (Béné 2005). This raises the question of the indirect exclusion or marginalization of these small-scale farmers who were not technically or financially strong enough to invest in these BMPs (Stanley 2000; Vandergeest 2007). An early expert consultation by FAO had recognized the issue:

> “…if codes of practice are over-prescribed in the sense that they promote a specific technical solution rather than promote a variety of solutions to achieve a specific outcome, then they will restrict innovation and discriminate unnecessarily against some producers. This is particularly the case for small-scale farmers where a particular GMP may have been handed down based on a highly technological approach.” (FAO, 2001: 27 – our emphasis).

Several recent studies (e.g. Khiem et al 2011; Haa et al. 2013) stress that BMPs still remain today a challenge for small-scale producers in developing countries. Like in the case of fisheries, however, there is no study that attempts to link specifically or to quantify the impact of this issue in terms of food security.

5.4 Summary of key governance points

FSN has not been well included in either the initial central state paradigm of fisheries management, or the more recent co-management paradigms. International governance, including the latest initiatives, also fail to provide for adequate inclusion of FSN issues, nor do they demonstrate inquiry into how best to link the FSN agenda with fisheries management conventional debates.

Two issues need to be addressed with respect to aquaculture governance, namely the question of secure and ongoing tenure over sites for food insecure people, and secondly, the small and medium enterprise survival issue of accessing BMP schemes to stay profitable.

6. Fish, food security and nutrition in the next 20 years

In this final chapter before the recommendations, the HLPE will review the recent ‘projections’ exercises that are available in the literature (e.g. FAO-OECD agriculture outlook exercise; UK-foresight exercise) and re-examine the main conclusions of these projections from a food security and nutrition perspective. A box on the specific case of the Pacific region will be included. The second part of the section will then consist in completing an informal foresight exercise where the HLPE will revisit the main points presented in the previous sections of the report in the light of the most updated projections of key-drivers such as population transition in developing countries (combination of population growth, urbanization, and increase in living standard), impact of climate changes on agriculture.

7. DRAFT Recommendations (work-in-progress – not to be seen as the final recommendations))[24]

Below are some draft recommendations
< not necessarily in priority order; not comprehensive: don't cover yet every chapter; need also to be tailored to the targeted audience>

1. *GLOBAL POLICY*

The premier global policy instrument for fisheries and aquaculture is the Code of Conduct for Responsible Fisheries (CCRF). Objective (f) of the CCRF is to **promote the contribution of fisheries to food security and food quality, giving priority to the nutritional needs of local communities.** In 2012, an UNFAO evaluation of the FAO support to the implementation of the CCRF found that development of the FSN and gender dimension of the CCRF had been weak.:

- The FAO should develop suitable CCRF instruments to guide and plan its own and its national, regional and organizational partners' work on the role of sustainable fisheries and aquaculture for FSN and gender equality. The instruments should:
  - be developed in a participatory manner, building on the experience of developing the SSF instrument;
  - not be restricted to policy and action for SSF but should address FSN needs throughout fish supply chains and should address FSN issues in fisheries of all scales;
  - include other relevant UN agencies such as ILO, WFP, UN Women, WHO and others; and
  - be presented to the UNGA via the CFS.

2. *GLOBAL REPORTING*

Fisheries and aquaculture are virtually absent in all global reports on food and food insecurity (e.g., FAO SOFA and the FAO food insecurity reports) and FSN is virtually absent from fisheries and aquaculture status reports (e.g. SOFIA). Both of these blindnesses should be overcome by developing a small set of indexes and situation reports on fish and FSN for the general food reports and the fisheries and aquaculture reports.:

[24] The current V0 draft contains, intentionally, very first tentative recommendations : these are to be seen NOT as the final recommendations of the HLPE, but as a work-in-progress, and are presented here as part of the process of their elaboration: they will be further screened against evidence, enriched. The HLPE is opened for as well as for further scientific and evidence-based suggestions on their operationalization and targeting.

- FAO food status, FSN and fisheries and aquaculture experts should lead the development of a small set of indicators measuring the status of FSN in relation to fish in the human nutrition, and specifically in fish supply chain linked communities, and conduct regularly (or encourage the state members to conduct regularly) assessments at local and national level, using these indicators.
- A particular endeavour should be made as part of this initiative to ensure that the contribution of fish to FSN is not reduced to its animal protein content but that fish specific lipid and micro-nutritional richness is appropriately captured and reflected in these indicators.

3. ***FISHERIES RESOURCE ASSESSMENT IN THE CONTEXT OF SUSTAINABLE FISHERIES GOVERNANCE***

It is noted that to the present, fisheries resource assessment and its links to fisheries management and governance has been dominated by developed country, industrial scale fisheries approaches and models aimed at maximizing the biological and economic returns from the resources. Conventionally, assessments stress improving the yields of higher value species, and generally larger fish, often treating fish species and sizes of importance to FSN as low value, by-catch or even forage fish for poultry and high value fish. These approaches are not suitable for use in fisheries and aquaculture for FSN, although certain of the scientific approaches and the governance contexts could be adapted and recreated to better suit the species, harvest practices, production systems and information relevant to FSN.:

- FAO could take the lead in a global effort to redevelop resource assessment tools and governance concepts suitable for use in improving the contribution of fish to FSN. Just as current resource assessment is developed for use in the fisheries management paradigm of the industrial fisheries, new approaches will need to be developed for use in the reality of fisheries governance relevant to FSN. These models should at the same time be more adapted to, and better captured small-scale fisheries specific characteristics. In these cases governance settings are less formal and more embedded in local and national customs, but are also subject to global drivers.

4. ***THE CENTRAL ROLE OF SMALL-SCALE FISHERIES IN FNS***

The analysis presented in this report confirms what an increasing number of studies have underlined in the recent past, namely that small-scale fisheries is a particularly relevant and legitimate entry point for food security and nutrition interventions in LIFDCs, in particular compared to larger-scale fisheries. On the basis of these findings,:

- FAO could continue their recent effort to raise the profile of small-scale fisheries at the international level through the existing instruments and guidelines, including the CCRF (keeping in mind Recommendation 1 above) or the recently developed Tenure Guidelines.
- Where small-scale fisheries are in competition with larger-scales operations, governments should systematically establish national policies and regulations that discriminate positively these small-scale fisheries.

- Efforts should be made to reform rapidly the way the international fisheries and ocean governance is currently operating, with the objective to drastically and rapidly improve the transparency and representativity of all the major international programmes and initiatives supported by the international community and ensure that the small-scale fishers are appropriately represented in these programmes.
- A particular effort is made by the international community to recognize, account for, and distinguish the specific place that small-scale fisheries hold in the current debate on IUU.

5. *FISH MAINSTREAMED IN NUTRITIONAL PROGRAMMES*

Because fish is more nutritious than staple foods, such as cereals, providing, in particular, high levels of animal protein, essential fatty acids and micronutrients, fish can play an extremely important role in improving the nutritional status of individuals, in particular those at risk such as children and pregnant and lactating women. Yet with some few exceptions, fish has so far been only marginally included in the international debate on food security and nutrition. Too many nutritional programmes are still not aware of, or not recognizing and building on the potential of fish for reduction of micronutrient deficiency.:

- The CFS should encourages the various UN agencies (UNICEF, WHO, WFP, and FAO) to mainstream fish into their nutritional programmes and various interventions that aim at tackling micronutrient deficiencies in LIFDCs. This should include interventions which:
    - Use fish as a complementary food to improve the nutritional status of children
    - Encourage children and women to eat nutrient dense fish through nutritional education at the community level
    - Reduce nutritional loss by disseminating better processing and cooking practices
- The CFS should encourage the CGIAR and its national and international partners to consider more systematically and more thoroughly the inclusion of fish into their current and future research programmes, as a cost-efficient alternative to bio-fortification programmes, in order to tackle micro-nutrient deficiencies.

6. *FISH, INTRA-HOUSEHOLD PATTERNS OF FSN AND GENDER*

Accepting the nutritional value of fish consumption, but noting the dearth of information on the gender dimension of intra-household FSN in fisheries and aquaculture linked communities, and more generally the absence of rigorous (i.e. based on, e.g., Randomised Control Trial) analyses aimed at better understanding the actual links between fish-related activities, fish intake and nutritional status::

- Development agencies (national and international) should routinely collect and use critical intra-household information on FSN, gender and fish, so as to improve targeting of FSN help to achieve better gender equity.
- A more systematic and rigorous analysis of the link between fish-related activities and nutritional status of individuals should be encouraged through the

establishment of national or international research programmes bringing together health and nutrition specialists with fisheries and aquaculture experts so as to gain a critical improved understanding of the pathways between fish and FNS.

7. *FISH, TERRESTRIAL ANIMAL AND PLANT DERIVED PROTEIN*

Fish, terrestrial animal and plant protein for FSN differ in their composition and efficiency of production from specific systems, but the current comparative information on production efficiency and effectiveness from a FSN perspective is limited, and weakly founded. Despite this limited and partial information, it is clear that relative to other livestock, fish farming is among the most efficient converters of nitrogen to complete human protein. It compares well with efficient poultry production.:

- A multi-national and multi-disciplinary collaborative research program be developed and funded by the international donor community to involve experts in each production system type (fish, animal, plant) in order to estimate comparative production parameters and so help guide investments for more efficient future resource use. A selected number of representative production systems should be used in which to conduct the research.

8. *FISH AND DISASTER RELIEF*

The World Food Programme and other organizations providing emergency relief rarely use fish products in their relief efforts, despite recognizing the importance of fish and terrestrial animal protein for a complete diet.:

- The WFP, in collaboration with FAO, investigate the options, costs and benefits for use of fish and fish products in emergency relief programmes.

9. *ENSURING INTERNATIONAL FISH TRADE DOES NOT NEGATIVELY IMPACT FOOD AND NUTRITION SECURITY*

Where some outcomes of fish trade are positive, e.g., in increasing national income, but negative impacts occur, e.g., malnutrition among local people in the trade localities, policies and practices should be developed to eliminate the negative impacts, while endeavouring to maintain as much of the positive impacts as possible.

- Countries that are involved in international fish trade develop guidelines, procedures and, if necessary, regulations for ensuring that the negative FSN impacts of trade are eliminated, while maintaining the positive impacts of the trade as far as possible.
- Companies trading fish internationally, including processing firms, should be required to operate in such a way as to enhance and not damage the FSN of local and migrant communities involved with their operations.

10. *REGIONALIZATION AND DOMESTICATION OF FISH TRADE*

Trade in fish products and access rights have been heavily influenced by international trading regimes and thus had favoured international trade to boost national trade balances and foreign exchange. When the impacts of international trade were viewed more broadly, however, substantial evidence was mounting that the positive impacts of international trade on FSN on national incomes and some fish workers were frequently accompanied by negative or mixed impacts on consumers, workers and on the fisheries resources. On the other hand, considerable evidence was found that regional and domestic fish trade held considerable positive advantages for all concerned. National governments redirect policy efforts and development assistance to domestic and regional fish trade, and in so doing provide support for FSN, especially through supporting the value chains based on small-scale fisheries, aquaculture and marketing.

11. *AQUACULTURE GROWING IMPACT ON FOOD SECURITY AND NUTRITION*

Aquaculture can add to wild fisheries production, be an alternative form of production or compete with wild fisheries. Its impact on FSN is therefore becoming increasingly critical. FSN will be favoured when aquaculture performs as a complementary source of fish to fisheries. To ensure this,

- Governments at national level and the FAO at the international level work together to establish a series of policies which systematically support the positive contribution of aquaculture to FSN. These policies should in particular consider the following issues:
    - Fish as feed: production of viable, profitable fish of low trophic levels (herbivorous, omnivorous) should be encouraged where feasible. Where high-trophic level (carnivorous) fish are grown, every effort must be made to find replacements for fishmeal and fish oil. Suitable promotion and education programs should be developed whereby small pelagic species that are used currently for fish meal are promoted as highly nutritious human food.
    - Land, water competition: the FSN contribution from both aquaculture and fisheries requires careful and purposive attention to creating and granting tenure to small-scale operators and the workers in larger scale operations.
    - Use of wild seed: juveniles and broodstock for aquaculture is a complex issue if considering its FSN implications because often small scale gatherers are involved in the collection. Such jobs are not usually sustained in the long term as successful aquaculture almost always tends towards closed life cycle culture, leaving behind CBA.
    - Aquaculture and fisheries products can compete and interact in markets. However, the form of interaction will differ according to the species and markets and each case needs to be considered on its own merits. Market shocks of any kind, including those that arise from trade disputes, can have sharp and destabilizing effects on fisheries and aquaculture. As developed countries are the major importers, developing countries are usually on the receiving end.

12. *IMPROVED FISH BREEDS FOR SMALL SCALE FARMERS*

Keeping in view the potential for increasing aquaculture production and conservation of feed resources through application of genetics, it is time the governments give importance for development/use of improved breeds of fish and make them accessible to small-scale farmers.

13. *RECOMMENDATIONS FOLLOWING KEY-FINDINGS OF CHAPTER 6*

To be completed

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