Aquaculture for Food Security, Poverty Alleviation and Nutrition (AFSPAN)

Final Technical Report

CONTENTS

EXECUTIVE SUMMARY

The objectives of the Aquaculture for Food Security, Poverty Alleviation and Nutrition (AFSPAN) project were to strengthen the knowledge base and develop new and more rigorous methodologies of quantifying the contribution of aquaculture to combat hunger and poverty, thus providing the evidence upon which sound strategies, policies and research programs can be developed to support the sustainable expansion of aquaculture to maximize its impact on food and nutrition security and poverty alleviation.

The three-year project was implemented by eighteen partners in eleven Asian, African and South American developing and Low Income, Food Deficit Countries (LIFDCs), encompassing the spectrum of development conditions and role of aquaculture in national economies. The partnership also included EU partners and international organizations.

A theory of change was elaborated and range of analytical frameworks, economic models and indicators, complemented by surveys and case studies developed. The contribution of aquaculture to national GDP, excluding multiplier effects, was found to vary from negligible in countries with emergent aquaculture sectors up to 5% or more of national GDP in countries where the sector is very dynamic. Aquaculture was shown to have helped lower global fish prices, increasing economic access for all but the very poorest consumers. Although households engaging in aquaculture were found less likely to be poor than those that did not, poor households too benefitted from engaging in fish farming, irrespective of scale of operation. Fish consumption rates of households engaged in fish farming were typically higher than national averages.

Both immanent (e.g. economic growth) and interventionist (the implementation of policies promoting aquaculture development, improving governance and capacity) factors, as well as institutional arrangements, public-private partnerships and pioneering companies and individuals, were found to be capable of creating enabling conditions for aquaculture growth. Socio-cultural factors, especially gender and ethnicity, were also important: interventions tailored to match given specific socio-cultural contexts were most likely to lead to successful adoption and retention and delivery of equitable development outcomes, thereby producing lasting impact on livelihoods.

The volumes of seafood exported from developing to developed countries were found to approximate those of seafood imported by developing from developed countries. While expensive seafood may be being exchanged for cheaper but not necessarily less nutritious seafood, thereby minimizing threats to food security, there remains a lack of supporting evidence that this is the case. With the exception of Bangladesh no policies or interventions linking fish, aquaculture and nutrition were found in study countries and little is included in nutrition education on aquatic animal foods.

Project outputs are being disseminated among the development community to help improve efficiency and coordination of development initiatives focused on aquaculture that promotes food and nutrition security and alleviates poverty and helps focus research on addressing researchable gaps. The development of science outputs has also begun.

CONTEXT

Since the end of World War II growth of global fish (fish + shellfish) supplies has outstripped population growth, effectively increasing per capita annual supplies from 9.9 kg in the 1960s to 18.4 kg in 2009[1]. Growth has been fuelled by rising demand for animal source food, including fish and livestock, the result of a range of drivers including increased economic access, changes in trade policies and market liberalization, urbanization and marketing[2]. During the first half of the post-war period increases in fish supply came from capture fisheries, thanks to massive private and public investments that resulted in a proliferation of larger, more robust and increasingly mechanized fishing craft and more effective means of locating, catching and preserving fish until landed. By the late 1970s, however, the majority of fish stocks was fully or over-exploited[3]. While aquaculture accounted for only 3-6% of global fish supplies in the 1970s[1] in the subsequent decades aquaculture has consistently been among the fastest growing animal source food sectors, to the extent that one fish in two now consumed is farmed[4].

Fish and other farmed aquatic foods are potentially of importance in two key respects with regard to poverty and hunger. First, fish is a nutrient dense food, rich in highly bioavailable quality (in terms of essential amino acids) protein, essential fatty acids and micronutrients[5], recommended as an essential part of a balanced diet[6]. The capture, culture and trading of fish also creates jobs, thereby generating incomes[7]. Recent estimates by the FAO are that between 27 and 57 million full-time equivalent aquaculture related jobs, almost three-quarters of which are in production[8]. The value of global fish trade exceeds that of all other animal proteins combined[9], contributing an estimated 0.5–2.5% of global GDP[10]. In some countries, such as Mauritania and Viet Nam, however, contributions may be as high as 10%, while in the smaller island states of the Pacific contributions can exceed 25% of GDP[11]. Developing countries account for approximately 80% of world aquaculture production[12].

Aquaculture and development: It is for the above reasons that aquaculture has been widely seen as worthy of investment for development purposes, enhancing food security, alleviating poverty and improving nutrition[13]. However, as is increasingly acknowledged, the knowledge base around the direct and indirect impacts of aquaculture on food and

[1] FAO (2012)
[2] Kearney (2010)
[3] Arnason *et al.* (2008)
[4] World Bank (2013), FAO (2014a), Waite *et al.* (2014)
[5] Hambreus (2009), Beveridge *et al.* (2013), Belton & Thilsted (2014)
[6] Kawarazuka & Béné (2010, 2011), FAO/WHO (2011).
[7] Kawarazuka & Béné (2010)
[8] FAO/WorldFish (2015)
[9] World Bank (2011)
[10] Béné *et al*. submitted
[11] Gillet (2009), Allison (2011)
[12] FAO (2010)
[13] Delgado *et al.* (2003), Subasinghe *et al.* (2009), Belton & Little (2011), Little *et al.* (2012), Waite *et al.* (2014)

nutrition security and poverty alleviation in developing countries LIFDCs is poor and the little detailed analysis that has been done remains inconclusive. There are marked geographical discrepancies in farmed fish supplies[14]. There is little information on the extent or effectiveness of investment in aquaculture development. Some have questioned whether the focus by governments and international development agencies on smallholders has been entirely apposite: is the adoption of aquaculture an appropriate strategy for poorer, more vulnerable households to escape from poverty[15]? However, others have countered that aquaculture can increase resilience to calamities such as drought, cyclones or HIV-AIDS[16]. While the focus on smallholders has been held responsible for the sluggish growth of aquaculture in Africa in particular others point to a lack of policy coherence for development as the root cause underlying the sector's mixed record in the continent[17].

Aquaculture and fisheries: Aquaculture is distinct from fisheries in terms of produce, value chain structure and employment and, often, economic benefits to value chain actors[18]. The stagnation of capture fisheries and the rise of aquaculture are shifting the main source of the fish we consume from marine to freshwater, from pelagic species, rich in omega three fatty acids, to firm white fleshed, less oily species[19]. Aquaculture and fisheries value chains differ too, in terms of numbers and types of actors[8], often targeting distinctive markets and with different social and economic outcomes as a result. The equitability of benefit sharing among aquaculture value chain actors is largely a function of value chain structure and governance, with the socially marginalized, including women and tribal people, often being relegated to poorly paid menial jobs such as processing or small-scale trading[20].

Fish, aquaculture and food and nutrition security: Global demand for fish is growing due to a combination of population growth, urbanization and increasing wealth[21]. With only very modest increases in yields from capture fisheries forecast, rising demand must be met by aquaculture. The World Bank recently concluded that per capita fish supplies will increase fastest in rich countries and in those parts of the world, such as China, where aquaculture thrives, leading to growing regional disparities between supply and demand[22]. Demand and consumption are likely to increase throughout Asia, but while the World Bank predicts increases in fish supply in Latin America, declines in consumption are likely (i.e. exports will increase). Most worrying, however, are the projected declines in consumption in sub-Saharan Africa, where, levels of food and nutrition insecurity and poverty are the highest in the world[23] and per capita consumption of animal source

[14] e.g. c.f. sub-Saharan Africa and Southeast Asia; Kassam (2013), Belton *et al.* (2014)
[15] Brummett *et al.* (2008, 2011), Beveridge *et al.* (2010), Dey *et al.* (2010), Pouomogne *et al.* (2010), Brummett & Jamu (2011)
[16] Little *et al.* (2007), Miller (2009), Nagoli (2009), Karim *et al.* (2014)
[17] Beveridge *et al.* (2010).
[18] Beveridge *et al.* (2013, Belton & Thilsted (2014)
[19] Beveridge *et al.* (2013)
[20] Weeratunge et al. (2010), Macfadyen *et al.* (2012)
[21] Kearney (2010), Merino *et al.* (2012), Beveridge *et al.* (2013), Tacon & Metian (2013), Waite *et al*. (2014)
[22] World Bank (2013)
[23] Fishing for a Future (2013a), Kurien & López Riós (2013)

protein is the smallest of any region[24]. Because fish makes up such a high proportion (32%) of animal-source foods in this part of the world food and nutrition security are especially vulnerable to both supply and demand side changes. The World Bank (2013) estimates that per capita fish supplies in sub-Saharan Africa is likely to shrink by 1% per annum, from 6.8 kg in 2010 to 5.6 kg in 2030, by far the lowest in the world (global average = 18.2 kg). Although fish is highly traded in international markets[25] the growing gap between supply and demand in the region is unlikely to be met by trade due to a combination of escalating real prices and insufficient income growth[26].

Aquaculture production methods are intensifying which, combined with reduced use of increasingly scarce and costly fishmeal and fish oil[27], are increasing reliance on crop-based feeds, with implications for the nutrient profile of and economic access to farmed aquatic products and global food and nutrition security[28]. Moreover, despite being a nutrient-dense food, there is little evidence to show that increasing access to fish is effective or cost-efficient in improving individual nutrition outcomes[29].

The sustainability of aquaculture growth: Aquaculture depends upon a wide range of provisioning and regulating ecosystem services - land, water, seed, feed and the dispersion and assimilation of wastes, including escaped farmed organisms[30]. At the farm level, consumption of ecosystem services is largely determined by species, system and production methods. However, the provision of ecosystems services comes not only from the immediate vicinity of an aquaculture operation but from across geographic scales. Thus production in one locale (e.g. tilapia in Egypt) may heavily depend on ecosystem services from elsewhere (e.g. soy from the Americas[31]). While land and water use per unit production decrease with intensity of production methods, demand for seed, feed, energy and ecosystem services to disperse and assimilate wastes tends to increase. Increased investment in technological innovation and transfer, use of spatial planning and zoning to guide aquaculture growth at landscape and seascape levels, shifting incentives to reward improvements in productivity and environmental performance and moving consumption towards low trophic level fish species are essential if future growth is to be sustainable[32].

Aquaculture, poverty and hunger: the evidence: Last, there has been little evaluation of or consistency in the methodologies and indicators used to assess the contribution of the sector to alleviation of poverty and hunger, resulting in a lack of evidence and consensus on the role of aquaculture in alleviating poverty and hunger[33].

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[24] Fishing for a Future (2013b)
[25] FAO (2012)
[26] Fishing for a Future (2013a), Béné *et al.* (2014)
[27] Tacon & Metian (2008, 2015)
[28] Karapanagiotidis *et al.* (2006), Tacon *et al.* (2012), Beveridge *et al.* (2013), Belton & Thilsted (2014), Troell *et al.* (2014a)
[29] Kawarazuka & Béné (2010), Allison (2011), Longley *et al.* (2014)
[30] Beveridge et al. (1997), Soto (2009), Béné *et al.* (2010), Hall *et al.* (2011), Troell et al. (2014b), Waite *et al.* (2014)
[31] see El-Fayed *et al.* (2014)
[32] Hall *et al.* 2011, Waite *et al.* (2014)
[33] see Kassam (2013) and Béné *et al.* (2015) for discussion

AFSPAN PROJECT OBJECTIVES

The three-year AFSPAN project set out to strengthen the knowledge base and develop new and more rigorous methodologies to quantify the contribution of aquaculture to combatting hunger and poverty, thereby providing evidence upon which sound strategies and policies and development and research programs could be developed to support the sustainable expansion of aquaculture to maximize its impact on food security and poverty alleviation. Our research partnership[34] sought to include research, development and technical experience and expertise, together with detailed knowledge of and access to a range of countries that encompassed the spectrum of human development conditions and role of aquaculture in national economies in Africa (Kenya, Uganda, Zambia), Asia (Bangladesh, China, India, Philippines, Viet Nam) and Latin America (Brazil, Chile, Nicaragua). The project was led and administered by the Food and Agriculture Organization of the UN.

Nine work packages were elaborated (Table 1). **WP1** deals with overall project management and is implemented by the Coordinating Partner, FAO. Following stakeholder and partner consultations **WP2** developed an integrated framework to quantify simply but rigorously aquaculture's contribution to reducing poverty and hunger in LIFDCs. The framework consisted of two components that separately evaluated the contribution of aquaculture to poverty alleviation and to food security. Project partners then implemented the comprehensive collection, synthesis and analysis of data on national and international cooperation in aquaculture in partner country partners in Africa, Asia and Latin America (**WP3**).

We designed **WP4** to foster understanding of how aquaculture systems, scale and enterprise structure and institutional arrangements improve rural livelihoods. Specifically, we set out to assess the financial viability of entrepreneurial aquaculture, including small-scale operations, and its contribution to poverty alleviation and food security. Enabling institutional conditions and arrangements for food security and poverty alleviation and successful public-private partnerships that were contributing to aquaculture development in project countries were identified.

Through **WP5** we set out to identify and understand local social and cultural assets and constraints to aquaculture development. Using both a literature review and country case studies we analyzed the social and cultural factors that enable or impede poor producers from successfully delivering food and nutrition security and poverty outcomes.

In **WP6** we proposed to review and assess the role of nutrition education programmes in promoting aquaculture products in food insecure regions. The best practices in nutrition education programmes in the participating countries were analyzed, with emphasis on food insecure regions and on population groups that are especially vulnerable to malnutrition (young children and women of reproductive age).

[34] see Annex 1.

Table 1. AFSPAN Work Packages (see Annex 1 for partner details)

WP Number	WP Title	Type of activity	Lead partner
WP1	Project management	MGT	FAO
WP2	Assessment methodologies, indicators and framework	COORD	IDS, Sussex
WP3	Review and assessment of national and international cooperation	COORD	FAO
WP4	Sustainable aquaculture systems and institutions	COORD	WorldFish
WP5	Social and cultural factors affecting aquaculture	COORD	WorldFish
WP6	Nutrition education in aquaculture	COORD	Copenhagen University
WP7	Trade and markets	COORD	Portsmouth University
WP8	Synthesis, policy guidance and coordinating arrangements	COORD	FAO
WP9	Communications and dissemination	OTHER	NACA

*MGT = Management; *COORD = Coordination; *OTHER = Communication and dissemination

In **WP7** we set out to review the global trade in and markets for aquaculture products, with a focus on the small-scale sub-sector. Our objective was to understand the effects of global trade and markets on aquaculture's ability to meet food and nutrition security objectives through analyzing food and nutrition security and international trade and evaluating trade regulations as drivers of global trade in and markets for aquaculture products.

WP 8 was designed to synthesize the findings of WP2-WP7. It develops recommendations and approaches to better coordinate efforts by EU Member States, LIFDCs, donors and development partners to promote efficient and effective investments in development and research to improve the contribution of aquaculture to food security, poverty alleviation, nutrition and human development. It identifies knowledge gaps and technology needs and provides policy guidance and fosters better coordination arrangements between countries, donor and development partners.

Through the actions taken in **WP9**, we planned to disseminate project outputs to countries and development partners in order to help improve efficiency and coordination in initiatives focused on development of aquaculture as a means of promoting food security and poverty alleviation. Future actions by project partners are also highlighted.

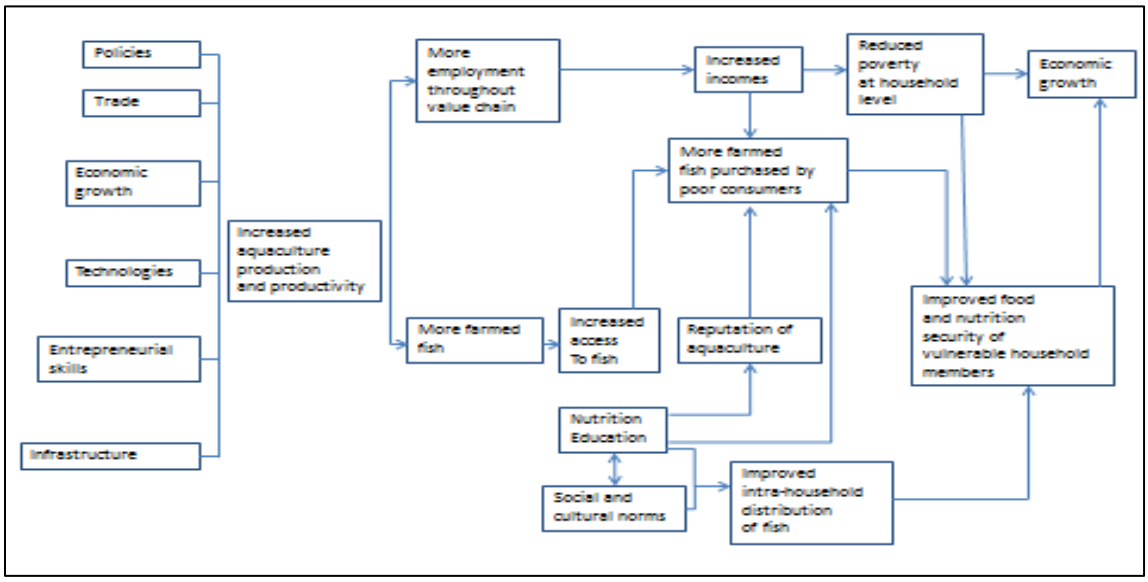
MAIN SCIENCE AND TECHNOLOGY RESULTS/FOREGROUNDS

INTRODUCTION

Although half of all fish consumed is now produced from farming the impacts of aquaculture on poverty and hunger remain contested because of lack of data, tools and models and appropriate development outcome and impact indicators. The resultant lack of hard evidence, combined with its recent rise to become a major source of food, conspire to exclude aquaculture from global initiatives on reducing poverty and hunger.

From the outset, AFSPAN set out to assess if and under what conditions aquaculture development reduces poverty and hunger and the most effective ways to do so. Our theory of change is summarized in the pathway in Fig. 1. The hypotheses underpinning our theory of change and the work packages used to test them are shown in Table 2.

Figure 1. The main elements of the pathway underpinning the AFSPAN Theory of Change



Not all hypotheses could be tested in AFSPAN. We decided, for example, not to explore the links between farmed fish consumption and health and thus, like the linkages between agriculture, food consumption and health, they remain poorly understood. The hypotheses on impacts of nutrition education on fish purchases and intra-household distribution among poor and socially marginalized people was also not tested in AFSPAN. While recognized, the trade-offs between use of ecosystem services to support aquaculture rather than for other purposes was not explored: for example, does expansion of aquaculture production result in loss of agricultural land that may have provided more economically accessible food; does lake-based cage aquaculture adversely impact on wild fish production, fisheries and livelihoods of poor and socially marginalized people?

Table 2. Summary of key hypotheses and the Work Packages that set out to test them

	Hypotheses	WP
1.	Fish is important in household food and nutrition security	2, 6
2.	Aquaculture can be an important driver of economic growth, sufficient to reduce poverty	2, 7
3.	More equitable intra-household distribution of fish will help meet the nutrition needs of vulnerable family members	6
4.	Poor consumers purchase more fish when it is readily available and meets their needs in terms of price and culturally determined preferences	2, 5, 6
5.	Improved access to information on fish, nutrition and health and changes in cultural and social norms will help ensure that vulnerable family members receive an equitable share of fish at mealtimes	5, 6
6.	Economic access by poor consumers will increase when farmed fish is cheaper, the result of increased production and productivity and of more efficient value chains	2, 7
7.	Aquaculture value chain actors have increased access to fish, either by consuming more of the fish they produce or trade, or by spending more of their income from aquaculture in purchasing fish	2, 6, 7
8.	Aquaculture creates relatively well-remunerated employment, thereby stimulating economic growth	2, 5
9.	Export of aquaculture produce benefits national economies and does not impact negatively on national food and nutrition security	2, 5, 7
10.	Aquaculture will thrive if essential inputs are available and the right policies, productive technologies and entrepreneurial skills are in place	2, 3, 4, 5, 6, 9

SYNTHESIS OF THE MAIN SCIENCE AND TECHNOLOGY RESULTS BY WORK PACKAGE (WP 2-7)

WORK PACKAGE 2: ASSESSING THE CONTRIBUTION OF AQUACULTURE IN COMBATING HUNGER AND POVERTY IN LIFDCS

BACKGROUND

It is often claimed that aquaculture contributes to poverty alleviation, economic growth and food and nutrition security in developing countries[35]. The claim with respect to aquaculture is relatively recent. However, despite rapid and sustained growth of the sector in the economies of an increasing number of developing/ emergent countries over the last twenty years, supporting data and robust analyses are often missing[36]. In WP2 we developed a simple integrated framework to rigorously quantify the contribution of aquaculture to poverty alleviation and food security in LIFDCs.

The framework that was applied to the 11 partner countries incorporates components on poverty reduction and food security into a single overall framework. In developing the

[35] Arthur *et al.* (2013), HLPE (2014)
[36] Arthur *et al.* (2013)

framework we tried to make it sufficiently generic to allow for comparisons and/or aggregation across and within different data contexts. The framework can also be applied even in data-poor environments and operates at both macro- and micro-levels, since both are relevant to assessing impacts on poverty and food security. The framework was also designed to allow for counterfactual and/or comparison with other sectors.

RESULTS

MACRO-ECONOMIC LEVEL

The analysis indicates that aquaculture's contribution to national GDP varies from almost zero percent in countries where the sector is emerging up to 5% or more of national GDP in countries where the sector is very dynamic (Table 3). On average, across the 11 partner countries, the aquaculture sector contributes 1.24% of national GDP. When compared to the rest of the economy and in particular to the agricultural sector, again the picture is largely country-specific. In some cases aquaculture represents >60% of the agricultural sector's contribution to GDP, while in others it represents <1% (Table 3). However, assessing the contribution of the sector by estimating the value of production alone is likely to lead to serious under-estimation. Our data suggest that for every dollar generated by the sector through direct sell, a further US$ 1.69 is created[37].

Table 3. Contribution of aquaculture to national GDP in the 11 partner countries (2010 data; see footnote[38] for data sources)

(Million US$)	Bangladesh	Brazil	Chile	China	India	Kenya
National GDP [(a)]	100,360	2,143,068	217,502	5,930,502	1,708,459	32,440
Aquaculture GDP[(b)]	5,879	1,201	4,983	83,591	12,677	57
% National GDP[(b)]	5.86	0.06	2.29	1.41%	0.74	0.17
Agriculture GDP[(a)(c)]	18.59	5.30	3.46	10.10%	18.21	25.11
% Agriculture GDP	31.51	1.06	66.14	13.96%	4.08	0.70

(Million US$)	Nicaragua	Philippines	Uganda	Viet Nam	Zambia
National GDP [(a)]	8,938	199,589	16,031	115,932	16,190
Aquaculture GDP[(b)]	126	7,062	369	6,687	74
% National GDP[(b)]	1.40	3.54	2.30	5.77	0.46
Agriculture GDP[(a)(c)]	18.56	12.31	25.68	18.89	20.45
% Agriculture GDP	7.57	28.73	8.97	30.53	2.25

Our analysis suggests that, unlike the much larger agriculture sector[39], aquaculture is not a strong element in the dynamics of poverty alleviation at the macro level in LIFDCs.

[37] The multiplier provides a first approximation of the wealth created through aquaculture that trickles down to the local level i.e. for every US$ 1.00 income generated by fish-farming an additional US$ 1.69 is generated in other sectors in the same region.

[38] [(a)]source: World Bank http://iresearch.worldbank.org/PovcalNet/index.htm; [(b)]source: this report; [(c)]percentage national GDP.

[39] Timmer (2002), Allison (2011)

Estimates of sector GDP elasticity of poverty show that although aquaculture growth has been impressive and positively impacts on poverty reduction the effect is not statistically significant.

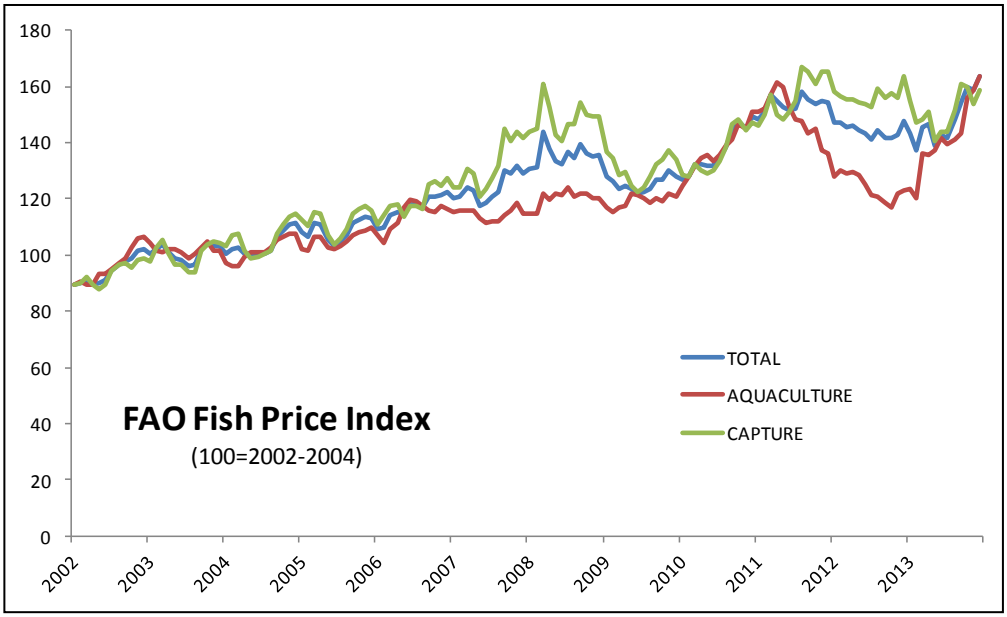
At the macro level we also determined whether aquaculture has influenced the dynamics of fish price determination. The analysis reveals that the price of aquaculture products does influence the aggregated fish price at the international market level, and has contributed in the last 10 years to keeping the global price of fish products lower than it would have been without aquaculture (Fig. 2).

MICRO-ECONOMIC LEVEL

The results from the assessment are also mixed at the micro-level. Our data suggest that the sector has a non-negligible income multiplier effect in the countries where fish farming operates: on average across the 11 countries included in this analysis, for every dollar generated by fish-farming activities, an additional US$ 1.3 is created at the local level through the sector income multiplier effect (Fig. 3).

The data suggest that aquaculture activities usually decrease inequality in communities where fish farming operates and that the poorest households are often among those which proportionally benefit most from engaging in aquaculture (see Table 4). However, data also indicate that total household and aquaculture incomes are strongly linked i.e. relatively rich households are much more likely to derive large incomes from aquaculture than poor households. In all cases, except in Chile and Kenya, however, increases in aquaculture income result in a decrease in Gini coefficient (Table 5).

Figure 2. Global fish - farmed, captured and total - price indices 2002-2013



At the household level, data suggest that per capita levels of income among fish farmers and fish farm workers equals or is greater than the average income per capita of the bottom 40% of the population in the same country, and may even equal or exceed the average national income.

The data also show that with the exception of the Philippines fish consumption rates of households engaged in fish-farming activities are higher than national averages. However, the same data also show that even where households have an above national average fish consumption rate, the proportion derived from self-production may not be equal the national average, suggesting that fish is also purchased in local markets.

Figure 3. Income multiplier effect of aquaculture for the 11 countries included in the programme (95% CI)

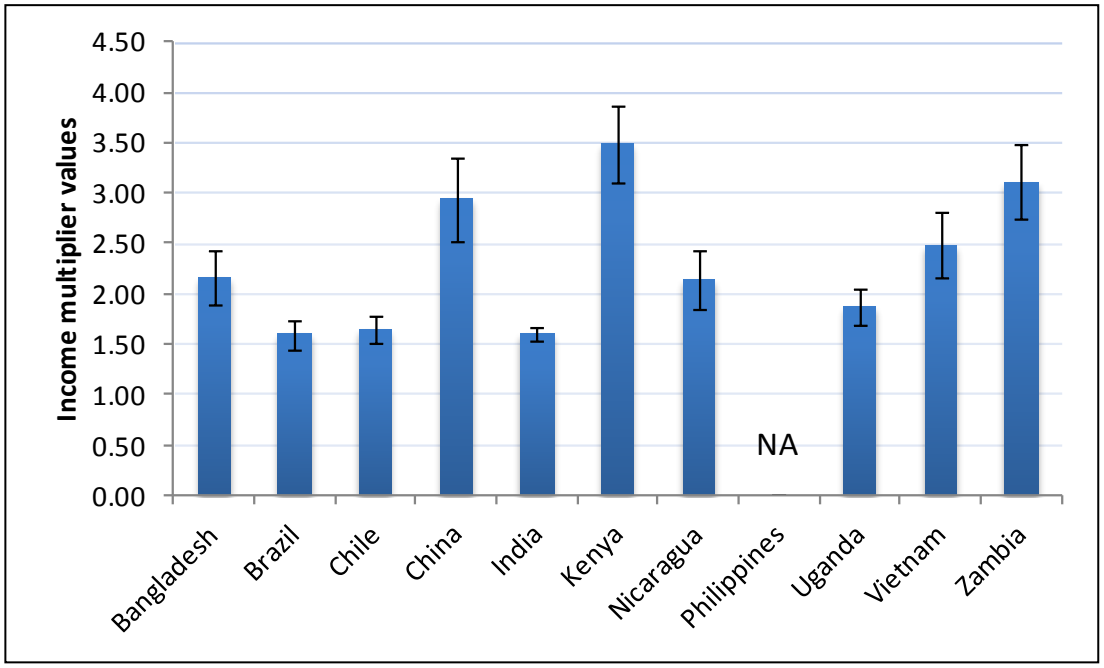


Table 4. Aquaculture and income generation in each country, expressed per household and per capita, as well as the average shares of aquaculture in household income for different poverty quartiles

	Fish farming income (US$)					Fish farming income (US$)			
	Quartile	Per household	Per capita	Share of total income	Quartile	Per household	Per capita	Share of total income
Bangladesh	1	207	60	0.97	**Nicaragua**	1	13	4	0.64
	2	414	114	0.81		2	37	12	0.90
	3	393	95	0.35		3	42	12	0.66
	4	483	117	0.22		4	58	20	0.22
Brazil	1	1,741	808	0.35	**Philippines**	1	503	134	0.72
	2	2,762	1,217	0.17		2	1,236	336	0.84
	3	6,202	2,178	0.19		3	1,402	296	0.68
	4	9,122	3,212	0.16		4	6,170	1,814	0.44
Chile	1	719	287	0.93	**Uganda**	1	61	22	0.31
	2	2,916	979	0.94		2	297	154	0.59
	3	4,397	1,632	0.89		3	310	133	0.27
	4	7,289	2,705	0.91		4	760	150	0.16
China	1	17,189	5,616	0.79	**Viet Nam**	1	6,471	2,092	0.09
	2	34,175	12,681	0.66		2	10,721	3,282	0.04
	3	48,626	16,534	0.46		3	25,740	6,376	0.02
	4	177,237	75,830	0.73		4	44,868	12,516	0.02
India	1	611	178	0.94	**Zambia**	1	74	24	0.57
	2	1,188	373	0.92		2	759	335	0.73
	3	1,371	400	0.83		3	533	127	0.28
	4	1,323	419	0.43		4	987	212	0.06
Kenya	1	565	138	0.53					
	2	826	277	0.33					
	3	837	208	0.23					
	4	7,247	2,579	0.32					

Table 5. Gini decomposition analysis: S_s: Share of total income; $G_{s:}$ Gini coefficient; Share: share of Gini coefficient; R_s Gini correlation coefficient

	Source	S_s	G_s	Share	R_s	Concentration	% Change
Bangladesh	Non fish-farming	0.71	0.73	0.93	0.98	1.30	0.21
	Fish-farming	0.29	0.34	0.07	0.41	0.26	-0.21
	Total income	1.00	0.55	1.00			
Brazil	Non fish-farming	0.83	0.46	0.87	0.99	1.04	0.04
	Fish-farming	0.17	0.43	0.13	0.80	0.79	-0.04
	Total income	1.00	0.44				
Chile	Non fish-farming	0.08	0.92	0.08	0.41	1.01	0.001
	Fish-farming	0.92	0.41	0.92	0.91	1.00	-0.001
	Total income	1.00	0.38	1.00			
China	Non fish-farming	0.58	0.90	0.67	0.89	1.16	0.09
	Fish-farming	0.42	0.69	0.33	0.78	0.78	-0.09
	Total income	1.00	0.70				
India	Non fish-farming	0.33	0.72	0.67	0.90	2.03	0.34
	Fish-farming	0.67	0.25	0.33	0.63	0.49	-0.34
	Total income	1.00	0.32	1.00			
Kenya	Non fish-farming	0.60	0.58	0.55	0.94	0.93	-0.04
	Fish-farming	0.40	0.73	0.45	0.89	1.11	0.04
	Total income	1.00	0.58				
Nicaragua	Non fish-farming	0.89	0.87	0.96	0.99	1.08	0.07
	Fish-farming	0.11	0.37	0.04	0.76	0.35	-0.07
	Total income	1.00	0.80	1.00			
Philippines	Non fish-farming	0.70	0.93	0.79	0.97	1.13	0.09
	Fish-farming	0.30	0.67	0.21	0.83	0.69	-0.09
	Total income	1.00	0.80				
Uganda	Non fish-farming	0.87	0.80	0.93	0.98	1.07	0.06
	Fish-farming	0.13	0.62	0.07	0.63	0.53	-0.06
	Total income	1.00	0.74	1.00			
Viet Nam	Non fish-farming	0.98	0.41	0.99	1.00	1.01	0.01
	Fish-farming	0.02	0.57	0.01	0.31	0.44	-0.01
	Total income	1.00	0.40				
Zambia	Non fish-farming	0.90	0.83	0.96	0.99	1.06	0.06
	Fish-farming	0.10	0.65	0.04	0.49	0.42	-0.06
	Total income	1.00	0.77	1.00			

WORK PACKAGE 3: REVIEW AND ASSESSMENT OF NATIONAL AND INTERNATIONAL COOPERATION

BACKGROUND

Ensuring adequate food and nutritional security for all is a formidable challenge that governments and international development communities must address, given a global population projected to rise from 7 to 9 billion by 2050, much of it in developing countries prone to hunger. According to the FAO, to feed the world in 2050, agricultural output from crops, livestock and fisheries, including aquaculture, must increase by 60 percent [40]. Finding opportunities to increase food security and alleviate poverty through agriculture is vital and timely. It is widely acknowledged that aquaculture also has an important and increasing role to play in addressing food insecurity and under- and over-nutrition by enhancing the supply and consumption of fish and other marine and freshwater products, which are rich sources of protein, essential fatty acids, vitamins and minerals, by generating higher incomes and employment opportunities and by enhancing trade, thereby reducing poverty and promoting social and economic development.

The objective WP 3 is to review past and ongoing national and international cooperation activities, focusing on those promoting aquaculture in a food security and nutrition context. The following sections summarize the key findings of the responses provided by the 11 country partners and of the analyses of selected international and regional aquaculture development organizations' programs to support aquaculture development, and then provides a set of recommendations for consideration by AFSPAN project partners. While the findings of partner countries and development organizations are reported separately, some are applicable to both since in most cases they jointly participate in aquaculture development initiatives. The same applies to the set of recommendations.

RESULTS

There are significant differences among the 11 partner countries in terms of the contribution of aquaculture to protein intake, national economic growth, species farmed, farming systems and employment generated (see also WP 2). The nature of regional and international cooperation activities also varied among the countries and depended on understanding of and willingness to address common issues to mutual benefit.

A review of the profile of the aquaculture projects implemented by the partner countries shows that while the primary objective of most projects is to reduce poverty and improve the livelihoods of fish farmers, the means to achieve it is diverse. The project support range includes, among others: technological research, gender empowerment, small-scale aquaculture development, climate change adaptation and mitigation measures and policy, strategy and sector planning elaboration. Further, in many cases, funded from both

[40] Alexandratos & Bruinsma (2012)

national and international sources, aquaculture is only a component of a fisheries, rural development or integrated water management project or program.

Data: Disaggregated data on key nutritional and socio-economic parameters to establish the contribution of aquaculture to food and nutrition security, employment and poverty alleviation are generally not available. In some cases, data on fisheries, i.e. including capture fisheries, as a whole is reported. However, in such cases, aquaculture's relative position could be gauged, given that its share in total fisheries production has increased substantially in recent years, to almost half, globally. Aquaculture's contributions to food security, nutrition, employment and poverty alleviation are sometimes reported at project level. However, there remain questions on methodologies and the robustness of analyses and consequently the impact being attributable solely to the project. While the contribution of aquaculture to national GDPs is small, its importance to national economies in terms of poverty alleviation and nutritional benefits were found to be significant in some of the case study countries (see also WP 2).

Guidance documents: The majority of project partner countries have fisheries (including aquaculture) policies, strategies and plans. The documents emphasize the importance of ensuring food security, reducing poverty and increasing income through fisheries and aquaculture development. Most documents had been prepared during the past decade, reflecting the influence of major regional and international commitments and agreements, such as the UN Millennium Development Goals, MDGs, 2000, and Bangkok Declaration and Strategy for Aquaculture Development Beyond 2000. Again, most partner countries include support to capture fisheries and aquaculture in national development plans.

Despite the widely accepted view that aquaculture makes an important contribution to human development, and the recent initiatives in developing aquaculture policies and strategies, the current knowledge and understanding of aquaculture's contribution remains inadequate. Consequently, fisheries, including aquaculture, are often all but absent in all global reports on food and food insecurity (e.g. FAO State of Food and Agriculture and the FAO food insecurity reports) and in aquaculture policy (e.g. the FAO Code of Conduct for Responsible Fisheries). However, the role of aquaculture in improving nutrition has been recently debated in a number of publications[41].

Impact of cooperation: Regional and international development commitments and agreements influence partner countries in development of fisheries and aquaculture policies, rules and regulations[42]. Regional and international development commitments and agreements generally focus on sustainable development such as food security and poverty alleviation. All organizations were found to be committed to sustainable development of aquaculture and recognize the importance of aquaculture's contribution, actual and potential, to meet the growing demand for fish, alleviate poverty and improve

[41] see FAO (2014a); also a paper on the role of sustainable fisheries and aquaculture for food security and nutrition presented at the Second International Conference on Nutrition in 2014; see also Troell *et al.* (2014b).

[42] e.g. the 2000 UN Millennium Development Goals, MDGs; the 2000 Bangkok Declaration and Strategy for Aquaculture Development Beyond.

food security and nutrition. The commitment of such organizations is reflected in the breath and variety of investment and non-investment support, mostly to developing countries. Given their respective mandates and comparative advantages, the support provided by some international organizations is readily summarized: FAO, technical (e.g. Secretariat to COFI/AQ); WorldFish, research (e.g. research focusing on generating and synthesizing knowledge for subsequent sharing and application); World Bank, good governance (e.g. design and implement good governance systems in the aquaculture sector, PROFISH); IFAD, small-farmer development (e.g. access to inputs and technical knowledge); ADB, integrated approach (e.g. aquaculture in the framework of natural resource development); and EC, policies and knowledge (e.g. AFSPAN project).

Partnerships: Partnerships are a cornerstone of sustainable aquaculture development. Organizations recognize that the magnitude and diversity of the aquaculture sector challenges calls for a concerted, long-term global partnerships to effectively and efficiently channel their technical and financial resources to support prioritized global, regional and national initiatives. The importance of forging partnerships with all stakeholders is embedded in development strategies and plans. For example, in FAO's revised Strategic Framework, facilitating "partnerships for food and nutrition security, agriculture and rural development between governments, development partners, civil society and the private sector" is one of the seven core functions. Similar emphasis is also evident in the CGIAR reform process, with partnerships seen as key in increasing development outcomes and impacts from international agricultural research.

Partnerships have led to establishing important milestones in the development of the aquaculture sector, for example the FAO-led 2010 Global Conference on Aquaculture, Phuket, Thailand (Subasinghe et al. 2012)[43] and the Global Partnership for Oceans (GPO), championed by the World Bank[44]. Partnerships have also been instrumental in establishing networks of aquaculture centers in various regions, such as The National Centers for Aquaculture in Asia in Asia and the Aquaculture Network for Africa[45]. The networks serve as mechanisms through which governments, international and regional development organizations and other stakeholders work together towards the development of the sector. Further, many governments have benefitted from FAO's South-South and Triangular Cooperation (SSTC) initiative, which is widely acknowledged as a complementary model of development cooperation to the traditional North-South model, in addressing development challenges and achieving food and nutrition security, poverty reduction and sustainable management of natural resources.

[43] http://www.fao.org/docrep/015/i2734e/i2734e00.htm.
[44] http://www.globalpartnershipforoceans.org/.
[45] NACA; http://www.enaca.org/); ANAF; http://www.fao.org/docrep/018/i3373e/i3373e00.htm).

WORK PACKAGE 4: SUSTAINABLE AQUACULTURE SYSTEMS AND INSTITUTIONS

BACKGROUND

Work Package 4 was designed to improve understanding of the role of aquaculture systems, scale, enterprise structure and institutional arrangements in improving rural livelihoods. Specifically, the objectives were to assess financially viable entrepreneurial aquaculture activities, including small-scale operations, and their contribution to poverty alleviation and food security; identify enabling institutional conditions and arrangements for food security and poverty alleviation, and identify successful public-private partnerships contributing to aquaculture development in developing countries.

Nine country case studies (Brazil, Chile, China, India, Kenya, Nicaragua, Philippines, Uganda and Viet Nam), augmented by two additional in-depth case studies from Bangladesh and India and a third case study, Ghana, commissioned externally to the project by WorldFish and included here for comparative purposes, were used.

METHODOLOGY

The purpose of the case studies was to provide a clearer understanding of the conditions and arrangements that enabled or prevented the development of aquaculture that helped alleviate poverty, reduce food insecurity, or improve nutrition either directly, through adoption of aquaculture (e.g. by raising farm incomes, increasing supplies of fish), or indirectly, through job creation or increase in fish supplies.

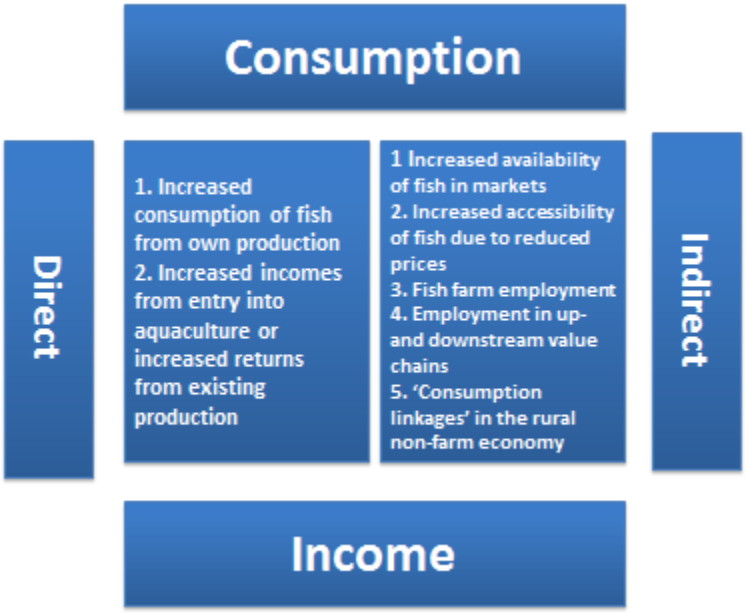
Each case study identified conditions and arrangements that had contributed to or prevented the development of aquaculture systems that met these objectives. The knowledge and experience of country partner institutions that was central to the case studies was supplemented by interviews with key informants and/or through informal discussions with other actors with a good understanding of the aquaculture system in question. Case studies also incorporated supporting secondary information from policy documents, project reports, government statistics, academic papers.

For each case study data were collected on the aquaculture operation location, species farmed, investment, farm size, feeding practices, production system, productivity, employment, markets, individuals and institutions involved (men/women, poor farmers, wealthy investors, companies, co-operatives etc.). In each case study quantitative (where possible) assessments were made of direct and indirect contributions to poverty alleviation and/or food and nutrition security. An analysis of the key conditions and arrangements that facilitated or constrained the development was made, as well as whether they were public or private sector, formal or informal and whether and how interaction between public and private sectors played a role in sector development**.** Last, the most important lessons from the case studies with respect to how and why the conditions and arrangements identified contributed to poverty alleviation or improved food security and nutrition outcomes were synthesized.

Analytical Framework: The most important direct and indirect benefits of aquaculture to the poor are likely to stem from improved food supply and/or employment and increased incomes. The nature of direct consumption linkages, direct income linkages, indirect consumption linkages and indirect income linkages, as shown in Fig. 4, are explored with reference to examples from the country case studies.

Table 6 provides summaries of each of the nine short and three in-depth country case studies and the summary of key points.

Figure 4. Key features explaining the contribution of aquaculture to poverty reduction[46]



The enabling conditions for aquaculture development are also examined. A distinction is made here between intentional or planned efforts, whereby government and non-government organizations implement projects and programmes to stimulate aquaculture development (intentional or interventional development), and the broad process of change in human societies driven by a host of factors (e.g. advances in science, medicine, the arts, communication and governance) that generally benefit aquaculture development (immanent development)[47].

[46] source: Toufique & Belton (2014)
[47] see Morse (2008), Belton & Little (2012).

Direct consumption linkages: Case studies from Bangladesh, Ghana, India (Chhattisgarh and Jharkhand), Kenya and Uganda found elevated levels of fish consumption among fish producers (Table 6). The examples reveal a mix of direct positive effects of aquaculture on food security. Increased productivity is shown to have resulted in increased consumption of fish by producer households. This includes small-scale subsistence or semi-subsistence producers, fishers benefitting from stock enhancement programs and commercial smallholder aquaculture producers who, in Bangladesh, were found to consume greater quantities of fish than their subsistence oriented counterparts. The Ghana case study, however, indicates that the direct food security implications of production may not always be well defined, and in some cases may not occur at all.

Indirect consumption linkages: It has been argued that the capacity of the extreme poor to benefit directly from aquaculture may be constrained by lack of assets and that the employment opportunities, while important, are finite and geographically concentrated[6]. It has thus been concluded that aquaculture has the potential to impact the largest numbers of poor people through indirect food consumption linkages, where aquaculture growth results in increases in the availability and access to fish, lowering fish prices relative to those of other animal source foods. Examples of indirect consumption effects were found in the case studies from Bangladesh, Ghana, India and Kenya (Table 6).

Although the section presents strong evidence that increased aquaculture production results in increased availability of fish and (in at least one case), reduced fish prices, it was not clear from the case studies alone whether this was in itself sufficient to guarantee that accessibility of fish to poor consumers is increased. In part this was because in the examples presented, production concentrated mainly on high value species. However, in many countries, low and medium value fish species account for a large proportion of fish produced. The case study from Bangladesh also raised the prospect that, at the community level, aquaculture may simultaneously improve producer food security, whilst eroding that of (often poorer) non-producers. Clearly, further research taking into account effects operating at a range for scales, is required in order to obtain a more complete understanding of these issues.

Direct income linkages: Increases in the incomes of adopting producers are among the most widely reported benefits of the adoption of aquaculture[48]. Increases in income may in turn translate into improvements in living standards, which may occur in the present or be transmitted inter-generationally. Examples of direct income linkages effects were found in the case studies from Bangladesh, Brazil, China, Ghana, Kenya, India, Nicaragua, Philippines, and Viet Nam (Table 6).

[48] e.g. Jahan (2010), Little *et al.* (2012).

Households that practice aquaculture were, on average, less likely to be poor than those that did not. This finding on its own reveals nothing about causality, however (i.e. do wealthier than average households adopted aquaculture or do households adopting aquaculture become wealthier as a result?).

Indirect income linkages: This section explores case study results with respect to two sets of indirect income linkages: employment generation, and economic multipliers, where the profits from fish farming or working on fish farms are re-spent on locally produced goods or services, thereby contributing to growth in the rural non-farm economy. Examples of indirect income linkage effects through employment were found in case studies from Bangladesh. Chile, China, India, Kenya, Nicaragua, Philippines and Viet Nam, while examples of indirect income linkage effects through economic multiplier effects were found in Ghana, the only case study to examine these effects (Table 6).

The case studies presented above indicate a variety of characteristics associated with employment related to aquaculture. Incomes gained from temporary and permanent on-farm employment and in the provision of services in related value chain activities span a wide range, as does the intensity of employment (number of jobs created per area land or unit of capital investment), reflecting the different local economic contexts in which aquaculture occurs and the varying labour demands of different production systems. One fairly consistent pattern is that wages and terms of employment in aquaculture tend to generate wages and employment conditions (e.g. stability of employment, working hours) that compare favourably with those in other agricultural sectors. This tendency may reflect the relatively unseasonal nature of aquaculture and the higher economic value of aquaculture products compared to staple crops (and hence higher economic productivity per worker). In some cases (e.g. Bangladesh), these factors mean that averaged over the course of a year demand for labour in aquaculture is higher than demand for labour in agriculture, although the reverse seems to be true in Andhra Pradesh, India.

The Ghana case study suggests that there are important differences in employment intensity between commercial and small scale systems, with pond aquaculture performing better than commercial cage culture when labour required for pond construction is factored in. However, in Bangladesh, commercial aquaculture systems generated much higher levels of employment than semi-subsistence ones. The Ghana case study in particular indicates that economic multipliers associated with the goods and services procured using incomes derived from aquaculture by producers and workers (i.e. consumption linkages) can be extremely important for economic development and poverty alleviation in terms of their effects on local economies. To date, these are poorly understood with respect to aquaculture, the Ghana study being the first of its kind to thoroughly investigate the existence of such linkages, and this area of study deserves prioritization in future research on aquaculture-poverty linkages.

Table 6. Summaries of each of the nine short and three in-depth country case studies and the summary of key points

Country	Case study description	Impacts on poverty and food security
Bangladesh	Compared six production operations (small-scale carp polyculture, intensive *Pangasius*, extensive tiger shrimp, integrated giant freshwater prawn) in three districts in terms of abilities of poor and landless households to participate as producers, the nature and extent of employment and effects on food security.	*Direct*: consumption and income increases. *Indirect*: increased availability of and access to fish and employment generation. Some negative/ ambiguous effects noted.
Brazil	Examined the role of cooperatives in supporting small-scale white shrimp farmers by improving technical and environmental performance, and impacts on co-operative members' living standards in NE Brazil.	*Direct*: increased incomes. Alternative livelihoods for fishers and increased farm economic performance.
Chile	Examined institutional factors enabling/disabling blue mussel and *Gracilaria* algae aquaculture development practiced at a range of scales and contributions to employment, incomes and food security.	*Indirect*: employment generation. Modest impacts on food security and poverty.
China	Documented the effects of agro-cooperative formation on the production and marketing of black carp in Wuxi.	*Direct*: increased incomes. *Indirect*: employment generation. Improved farm profitability.
Ghana	Compared economic multiplier effects associated with small and medium scale commercial tilapia cage culture and small-scale pond culture in Ghana.	*Direct*: consumption and income increases. *Indirect*: increased availability of and access to fish and economic multiplier effects, especially from pond aquaculture.
India 1	Examined government scheme promoting culture-based fisheries in nine reservoirs in Chhattisgarh and Jharkhand states as a means of alleviating poverty among disadvantaged fisher communities.	*Direct:* increased consumption. *Indirect*: increased availability of and access to fish. Increased productivity.
India 2	Documented dramatic growth of pond based semi-intensive Indian major carp and intensive *Pangasius* farming Andhra Pradesh.	*Direct*: increased incomes. *Indirect*: increased availability of and access to fish, increased employment. Major impacts on economic development.
Kenya	Described effects of sustained government program to stimulate development of small-scale aquaculture throughout Kenya via pond construction, provision of production inputs and services and the promotion of fish consumption.	*Direct:* consumption increases, income increases. *Indirect:* increased availability of and access to fish, employment (esp. pond construction)
Nicaragua	Evaluated institutional strengths and weaknesses of women's shrimp farming cooperatives in Occident region, Nicaragua and their successes and failures.	*Direct*: increased incomes. *Indirect*: increased availability of and access to fishery products and employment generation. Farm incomes improved.
Philippines	Explored the role of public and private sectors in stimulating small-scale seaweed farming, Bohol and Guimaras provinces, and the livelihoods of seaweed producers.	*Direct*: income increases *Indirect:* increased access to and availability to fish, employment generation.
Uganda	Assessed the geographically mixed results of government promotion of small-scale pond aquaculture throughout Uganda and identified factors associated with successful aquaculture development.	*Direct*: increased consumption and some income increases.
Viet Nam	Examined the effects of a government decree allowing farmers to convert low productivity, low-lying rice paddy into aquaculture, Bac Ninh Province.	*Direct*: increased incomes. *Indirect*: employment gene- ration. Increased productivity.

WORK PACKAGE 5 SOCIAL AND CULTURAL FACTORS AFFECTING AQUACULTURE

BACKGROUND

Success or failure of any development intervention is largely dependent on human capital (the skills, knowledge, ability to labour and good health that together enables people to pursue different livelihood strategies and achieve their livelihood objectives), social capital (the social resources upon which people draw in pursuit of their livelihood objectives such as networks and connectedness, membership of more formal groups, and relationships of trust, reciprocity and exchanges) of households and a range of socio-cultural factors that include culture, religion, beliefs, ethnicity, caste, nationality, social norms and gender; these socio-culture factors are not discrete but interact simultaneously. Development interventions must be harmonized with given specific socio-cultural contexts for successful adoption and retention of development interventions.

The objectives of WP 5 were to identify and understand local social and cultural assets and constraints to aquaculture development through an analysis of social and cultural factors that enable or impede poor people's engagement in aquaculture through a literature review and through country case studies.

METHODOLOGY

Literature review: The literature review utilized an on-line search of relevant literature in journals and websites of various organizations (UN, INGOs) to document existing knowledge of the socio-cultural factors that enable or impede aquaculture from successfully delivering equitable development outcomes, in terms of food security, nutrition and/or income.

An analytical framework was developed from the review in order to assess the socio-cultural factors that enable or prevent aquaculture from successfully delivering equitable development outcomes. Socio-cultural factors, among others, mediate the aquaculture technologies that are available in communities and to whom; technology adoption; decision-making within and across communities and households; the households and individuals that adopt; how aquaculture is used and who is responsible for labour and/or decision-making on production, harvesting, post-harvest, marketing and investment activities; and once in use whether aquaculture technologies deliver desirable development outcomes (enhanced food security, nutrition and/or income) within and across households, especially among marginalized populations. The literature review thus focused on analyzing the outcomes of aquaculture adoption in terms of human and social capital; tension and conflicts; gender relations; ethnicity; food preference and nutrition; intra-household distribution of fish.

Country case studies: Guidelines for country case studies were prepared and circulated to AFSPAN country partners to ensure uniformity of structure and focus. Case studies were received from eight partner countries from Africa (Kenya, Uganda and Zambia), Asia (Bangladesh, China, India and Viet Nam) and South America (Brazil). They focused

on the social and cultural factors that enabled or disenabled aquaculture development but most also included inter-related technological and institutional aspects. Feedback was provided on each case study received, revised submissions incorporating feedback.

RESULTS

The principal findings from the eight case studies are summarized in Table 7.

The literature review and case studies indicate that the socio-cultural characteristics and dynamics of individuals, households and communities strongly influence the outcomes of aquaculture through enabling or impeding factors, and that their influences are highly context-specific. At the level of individuals, these socio-cultural factors include technical knowledge and skills and factors that determine identity, such as gender, age, ethnicity, caste and health. Within households, they include gendered power relations involving adults and children. At the community and societal levels, they include prevailing cultural norms and values and the forms and nature of social relations, such as traditional forms of social capital. Interactions among these levels were complex and context-specific.

Enabling socio-cultural factors: The major socio-cultural factor enabling the successful development of aquaculture in a community is knowledge of aquaculture technologies and the skills and resources to use the technologies to achieve livelihood objectives. Most global aquaculture production occurs in Asia, especially in river basins and coastal areas of Bangladesh, China, India, Indonesia, Philippines, Thailand and Viet Nam. This is because of the socio-cultural significance of fish in the diet, traditional indigenous technical knowledge and/or more recent introduction and adoption of aquaculture by communities familiar with fish. In contrast, aquaculture has been slow to develop in Africa because of lack of knowledge or low social acceptance, despite a huge unmet demand for fish. It has now been realized that small-scale aquaculture targeted at poor farming communities will only succeed if the technology, appropriate aquaculture knowledge and skills in economic as well as socio-economic terms, match the given social and cultural contexts and can produce significant income for households. A key issue for households is thus to assess the relative merit of aquaculture compared to other livelihood options to achieve livelihood outcomes. Similarly, a farming household that has adopted aquaculture will decide whether the knowledge and skills they have gained are sufficient for aquaculture to compete with more remunerative livelihood options, either on-farm such as crops or livestock and/or off-farm, such as employment in urban areas or industry, and either part or full time employment.

There is a need to distinguish between what may be characterized as 'apparent adoption' of aquaculture when farming households receive project subsidies and 'sustainable adoption' indicated by households deciding to invest their own finances, resources and time for aquaculture to remain part of their livelihood after assistance is withdrawn. It is now generally appreciated even in sub-Saharan Africa that aquaculture needs to become a small or medium scale enterprise (SME) to adequately address the major livelihood objective of poor farming households, which is not only to improve food security of farming households but also to generate income. While the process of introducing an

aquaculture technology to a target group is an institutional issue within the remit of extension, the decision by farming households whether or not to continue with aquaculture following withdrawal of project support is clearly a socio-cultural issue.

Table 7. The eight case studies that examined the social and cultural influences on uptake of aquaculture

Country	Case study summary
Bangladesh	Crab fattening. While crab fishing and consumption are traditional among Adivasi people crabs are not eaten by Muslims and Hindus, although there are no social/cultural taboos against crab culture. Over the last few years, both Muslim and Hindu people, however, have been eating crab and the quantity of consumed crab gradually increasing. Crab fattening technology introduced to poor and landless Muslim, Hindu and tribal communities thus emerged as viable alternative livelihood options, a buoyant but mainly export market, women's active participation, and a requirement for limited land being suitable as a livelihood option for landless farmers.
Brazil	Reservoir cage culture. The introduction of cage culture of tilapia in one of the largest reservoirs in Brazil provided displaced resource-poor households with viable alternative livelihoods in a semi-arid region vulnerable to drought and erratic rainfall and at the same time reduced widespread exodus of the labour force through provision of increased employment opportunities.
China	Rice-fish farming. Despite a long history in some ethnic communities, traditional rice-fish practices have low productivity. Technological interventions to improve performance of rice-fish farming have been widely adopted and have led to increased fish consumption and incomes, increased eco-tourism through a special local fish delicacy and increased participation of women and the elderly in rice-fish farming.
India	Mussel culture. Mussels are not traditionally part of the diet in India. Through a newly introduced farming system in Kerala, it has become socially and culturally acceptable with good markets: 75% is sold in distant markets and 25% consumed locally. The rapid growth in mussel farming was attributed to strong social unity, including the dynamic role of women's self-help groups.
Kenya	Pond fish culture. Aquaculture in Kenya is largely constrained due to the belief that farmed fish are less tasty than wild fish, with almost two-thirds of consumers preferring wild fish. Marketability of farmed fish also depends on size, as large fish fetch higher prices.
Uganda	Pond fish culture. Despite having a favourable resource-base aquaculture growth is constrained by socio-cultural factors. Men largely carry out small-scale aquaculture. Farming of fish is taboo in cattle farming communities because of a belief that fish negatively affect milk production. Consumption of fish is also taboo in some communities: consumption of fish without scales is forbidden among some religious groups, while Buddhists (~1% of the population) do not eat fish at all.
Viet Nam	Reservoir cage culture. Small-scale cage culture is traditionally practiced in the northern mountainous provinces of Viet Nam. Cage culture has been promoted in a reservoir in Bao Linh commune since 2005 but productivity is low due to various socio-cultural constraints: low levels of education among ethnic minorities, a language barrier to delivery of training, lack of their participation in meetings, and limited participation of women in meetings and in decision making.
Zambia	Cooperative reservoir cage culture. There has been a major increase in company-based caged production of fish in Lake Kariba, the second largest man-made lake in the world. A Women's and Youth Cooperative successfully pioneered small-scale cage culture through the sale of fish. However, the lack of absence of men to operate the boat and dive to clean nets, and low interest of youth, were major constraints to sustainable aquaculture development.

The formation of groups, cooperatives or clusters has been shown to be an important enabling factor in communities with strong family, clan or community bonds. Farmers cooperate to build fishponds and to guard them and readily agree to cooperate communally, at least in input and output markets, to better access seed and feed inputs, to market produce, and to receive technical advice from government extension agencies. Furthermore, areas where there are clusters of aquaculture farms are likely to be in well-endowed areas for fish production and thus are more likely to be sustainable and be able to deliver adequate livelihood outcomes.

The inclusion of women in small-scale aquaculture has been demonstrated to provide household benefits. Although women are relatively less involved in carrying out heavy physical tasks such as building ponds and harvesting fish, they are actively involved in routine tasks such as feeding fish, monitoring fish production and post-harvest handling, which complements their household chores. The involvement of female household members has proved effective tool in their empowerment due primarily to improved access to and control over resources. It has also been demonstrated that the involvement of women in aquaculture leads to an increase in the household consumption of fish, thereby benefitting family nutrition as well.

Impeding socio-cultural factors: Gender norms and relations are among the most important socio-cultural constraints on the ability of individuals to pursue aquaculture effectively. While gender norms vary with context, in general they are a barrier to women's efforts to practice aquaculture, in particular for the purpose of earning an income. Among other things gender norms and relations put women at a disadvantage relative to men through restricting their access to information and skills, limiting their contact with other actors in the value chain and preventing them from spending sufficient time on aquaculture to maintain efficient, productive fish ponds.

The development of aquaculture in a community, while benefiting those involved in farming fish, may exclude other members of the community. It may, for example, lead to the exclusion of landless labourers from rice fields and water bodies where they catch fish for home consumption and sale. This can exacerbate tensions and promote conflict, especially in Africa and the Indian sub-Continent, where farmed fish may be poached or even poisoned. Such sabotage may also result from envy or 'social levelling', especially in Africa. Such negative behaviour can sometimes be overcome by adopting a community based approach involving non-fish farmers in farm labour or other employment opportunities along the value chain created through increased fish production in the community. Aquaculture programmes need to include strategies for sharing the benefits of aquaculture as widely as possible throughout communities to reduce the potential for conflicts and sabotage. Where aquaculture is not a viable livelihood option, for instance for landless people, alternative livelihood options associated with aquaculture could be created with pro-poor development a priority[49].

[49] Cai *et al*. (2012).

The average age of farmers in developing countries is in the increase as most youths seek better-paid and less physically demanding employment; nor do their parents encourage them to become farmers. Older farmers with lower levels of education are also less likely than the young to adopt new technology. Perhaps the only way to address these issues is to make aquaculture more profitable as well as less labour intensive, probably through intensification of production through farming higher value and genetically improved species, use of better seed quality, increased use of better quality feed prepared in environmentally friendly and cost effective way, and better management.

Ethnic minority groups within countries are often actively discriminated against because of racial prejudice or passively because they inhabit remote areas. However, there are a few examples of successfully targeted project interventions are the Tharu in Nepal and the Adivasi in Bangladesh.

While global production and consumption of fish continues to increase, fish consumption is constrained in some communities by taboos against all fish through religion or food choice (e.g. by vegetarians) or by taboos against certain types of fish (e.g. fish without scales). There are also myths constraining aquaculture such as the belief in Uganda that production of fish reduces milk production by cows. Taboos are hard to overcome but should be carefully considered during aquaculture development initiatives, and where appropriate might be addressed through education

WORK PACKAGE 6 NUTRITION EDUCATION IN AQUACULTURE

BACKGROUND

Fish and other aquatic foods have the potential to contribute to good nutrition and health due to multiple beneficial nutritional qualities, such as high protein quality and specific beneficial fatty acid profiles. Improving nutrition in populations through increased intake of fish and seafood requires access to the foods, as well as individual decision making to include the products in the diet. Nutrition education programmes are one approach to impact and to induce behaviour change towards a better dietary strategy. Specifically, food insecure populations are vulnerable to malnutrition, and within these populations, young children and women of reproductive age are the most vulnerable.

The aim of WP 6 was to map links between nutrition education and aquaculture production in AFSPAN partner countries. We investigated how aquaculture products are (or have failed to be) integrated into and targeted by programmes aimed at improving nutrition in food insecure populations in general and in vulnerable population groups in particular. Aquaculture programmes and nutritional programmes in partner countries were mapped and best practices identified from the findings of programmes connecting either aquaculture specifically or fish consumption in general.

METHODOLOGY

In order to map the links between nutrition education and aquaculture production in AFSPAN partner countries the following information and data were collected:

- Information on the national food supply patterns was extracted from the FAO statistical database (FAOSTAT) as a comparable measure of the role of fish and seafood in national dietary patterns. Data were extracted as an average for the period 2009-2011 to level out annual fluctuations in food production.
- Information on activities that connect nutrition education, aquaculture production and promotion of fish consumption. Using data from the WP 3 AFSPAN report, which identified all aquaculture programmes and projects the past 20 years. A protocol for information collection was developed and distributed to partners and the information collected via stakeholder contacts, literature reviews, project documents and other available sources.

Based on the material from the mapping of activities, a discussion of how best to link nutrition education to fish consumption (and aquaculture in particular) was conducted with the partner countries during the 2nd project workshop.

RESULTS

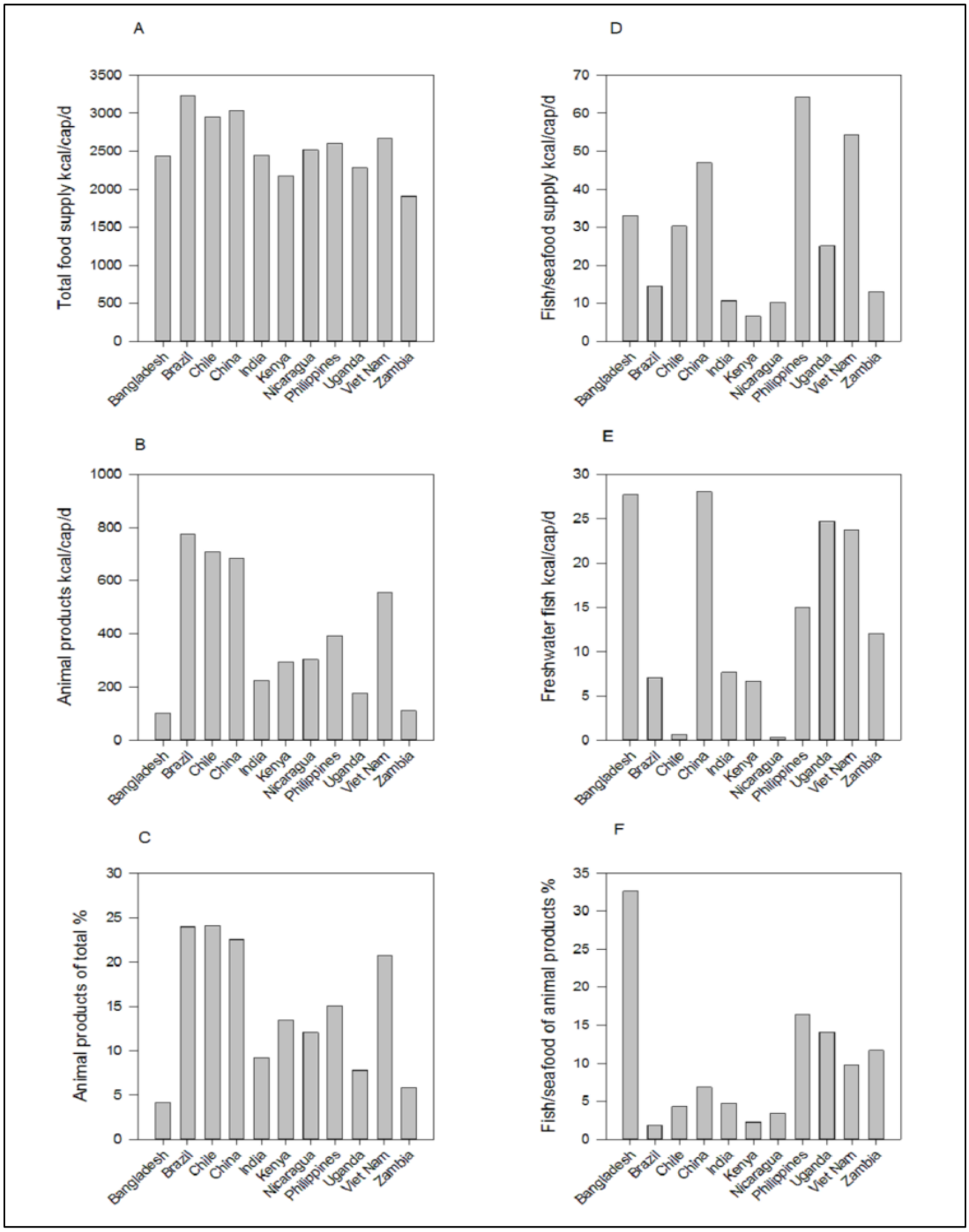
The role of fish in the dietary pattern in the AFSPAN countries: Using FAOSTAT data, the role of fish and aquatic foods in diets differ widely between countries and regions. Asia has stronger traditions of fish consumption that Africa and South America, which is reflected in the supply data. Bangladesh stands out in particular: it has a low per capita food supply with a minimal supply for animal products (< 10 g protein/cap/d), but about one third of this supply is fish – mainly freshwater fish (Table 7).

Nutrition education: The mapping of partner country nutrition education programmes aimed at promoting increased consumption of either aquaculture products (sector specific approaches) or fish in general (public health approaches) found that the direct integration of nutrition education programmes with aquaculture programmes is scarce. Moreover, there has been no systematic, independent monitoring and impact evaluation to provide sound evidence of impact on nutritional status. A number of partner countries did not identify aquaculture programmes with specific nutrition education elements. Programmes with the primary objective of improving health and nutrition can incorporate technical components to promote specific food production in households. One programme in Bangladesh incorporated aquaculture into the promotion of higher incomes and better nutrition. This was also the only programme we identified to have been monitored and whose impact had been independently evaluated.

School feeding programs: School feeding programs are a common way to provide children at least one nutritious meal a day in many developing countries, increasing school attendance, improving performance and enhancing the nutritional status of the

children. Fish in school meals are not always an obvious choice e.g. due to price, food culture or availability. However, some countries – e.g. Bangladesh, Brazil, Chile, China,

Figure 5. Food supply in AFSPAN countries, expressed as dietary energy (kcal/capita/ day). A: total supply. B: supply from animal products (meat, fish, dairy, egg). C: proportion of total supply from animal products (%). D: total supply from fish/seafood. E: supply from freshwater fish. F: fish/seafood: animal product supply (%).



Kenya - have recognised the potential of fish as an excellent source of micronutrients, essential fatty acids and animal protein and the importance for children's growth and development, recommending fish be included in school meals once or twice a week.

Campaigns are another way of promoting fish consumption. Fairs and fish festivals and media based campaigns were found to be being used in Bangladesh, Brazil, Chile, India and Nicaragua to promote fish consumption among the wider population.

WORK PACKAGE 7 TRADE AND MARKETS

BACKGROUND

The primary objective of work package 7 is to understand the global trade in and markets for aquaculture products, focusing on the small-scale production sector and the effects of global trade and markets on enabling or preventing aquaculture from achieving its food security objectives.

METHODOLOGY

The two activities undertaken in the work package were a review of primary and secondary information on production and trade in aquaculture products over the past decades, undertaken by the University of Stavanger. The University of Portsmouth carried out an analysis of trade and trade regulations as drivers of change in the aquaculture chain and the consequences for food security, poverty reduction and nutrition, based partly on case studies from partner countries. The study had three components: (i) an analysis of major trade and trade regulations dynamism over the last ten years; (ii) analysis of the way trade and trade regulation is perceived as signal by key aquaculture chain actors; and (iii) assessment of the effect of trade and trade regulation on poverty, food security and nutrition.

RESULTS

International trade patterns and food security: The broad theme of international trade and how it affects levels of poverty and hunger was considered for seafood exporting developing countries. Although the theory of comparative advantage hypothesizes that trade leaves no country worse off in the aggregate, international trade does generate winners and losers within a given country. There is thus cause to be concerned about the food security of vulnerable individuals in food-exporting LIFDCs.

Seafood contributed at least 15% animal protein consumption to 2.9 billion people worldwide, and fisheries and aquaculture directly employed 43.5 million people in 2006, with 520 million people indirectly deriving their livelihoods from seafood-related industries. We considered the evolution of trade flows – values, quantities, and prices – between developing and developed countries. The impact of seafood trade on food security continues to create controversy because it is viewed as moving large volumes of

fish of high nutritional value from poor (i.e., developing) to rich (i.e., developed) countries. Food sovereignty thus remains an issue. While it is more apparent when measured in value than in volume, the seafood trade deficit can be viewed negatively if any reductions in the availability of a specific food source are considered a negative outcome. However, if it is accepted that some food types can substitute for others, increasing LIFDC export earnings and incomes allows for purchases of more (and more nutritious) food, thus improving poverty and hunger outcomes.

The picture that emerges from case study countries suggests that the quantities of seafood exported from LIFDCs to developed countries approximates the quantities of seafood imported by developing countries from developed countries. What takes place is a value exchange: developing countries export high-value seafood in exchange for less expensive, but not necessarily less nutritious, seafood. This result is consistent with Bennett's Law, which states that as people become wealthier, they substitute away from low-quality (in this case, cheaper) foods toward higher-quality (i.e. more expensive) foods. Note that the term 'quality' is perceived quality and, indeed, cheaper fish are often more nutritious, being oilier (i.e. higher levels of Omega-3 fatty acids) and smaller and thus eaten whole (calcium in fish bones is as bioavailable as that in milk). Thus, the international trade of seafood does not necessarily undermine food security, although it was not possible in this study to determine how developing countries use the income from seafood exports.

Trade and trade regulations as drivers of change in global trade and markets for aquaculture products: With regard to trade patterns in case study countries, most reported an increase in fish production during the last decade. However, the contribution from aquaculture in terms of food security, economic development and nutrition varies. The analysis of trade patterns suggests several reasons why this might be the case, including end markets, government support and assistance, ability to react to changing market demands, ability to adopt regulations required for market access (both domestic and international), production scale and investment in infrastructure. Two main shortcomings were identified in restricting growth in aquaculture output: access to inputs and technical know-how and education.

The extent to which these factors are limiting depends on production type, scale and product destination. For example, aquaculture in Viet Nam has increased by over 11% per annum in the last decade and largely consists of low value species for export markets. However, in other countries production remains very low, subsistence orientated and sometimes of poor quality, even for domestic markets. Yet other countries, such as Brazil, which in the last decade have targeted the export of high value species, have seen a reduction in seafood production as a result of trade regulation and barriers. We therefore conclude that among case study countries, trade patterns and trade regulations have impacted on growth. However, other export orientated countries, like Chile, have implemented regulatory programmes governing the production of important export species such as Atlantic salmon to retain market position in developed markets (e.g. USA and the EU). Chile and Bangladesh are the exception in this regard, although Bangladeshi processors report having to meet ever-changing standards in developed markets.

Analysis of how trade and trade regulation are perceived as signals by key aquaculture supply chain actors: The impact of trade regulations on food security and/or economic growth depends on many factors, including scale of production and product destination. Market signals are better understood by export-orientated producers, such as Bangladesh, China and Viet Nam. Scale of operations and investment in production efficiency tend to drive export opportunities – countries such as Bangladesh, China, Viet Nam and Brazil have scale and investment in high value sector, although current exports from Brazil are low and farmers tend to focus on domestic markets. However, Bangladesh, which suffered similar trade regulations to Brazil, has taken steps to ensure that sector development focuses on exports to the main consumption centres and have addressed quality and other issues in order to do so. Processing requirements and product differentiation can pose problems for countries wishing to export aquaculture products. Technical barriers to trade include technical regulations, quality and composition standards, labelling, and source and origin information requirements. Many of these barriers can be overcome by adopting the HACCP principles and other standards such as ISO in target markets.

Trade and trade regulations were found to be driving change in small-scale aquaculture. Aquaculture, for most case study countries, is contributing to food security. Export opportunities have led to economic development as well as having contributed to improved food security in some case study countries. Supply chain enhancement (infrastructure, transport, product care and storage, processing, marketing etc.) is required to scale up small-scale producers. Government strategy and support will play a major role in both achieving food security and economic development.

Effects of trade and trade regulation on poverty, food security and nutrition: The extent to which aquaculture can contribute to food security, poverty reduction and economic development objectives is greatly determined by the mechanisms – policies and technical interventions - provided to promote the sector and support for the development of small and large-scale operations. Evidence from the case study countries is clear - export markets are very demanding in terms of product type, quality and traceability. Food safety is a major concern in developed markets. Within the small-scale sector in non-export orientated case study countries there is little perception of market signals due to a lack of information and technical know-how regarding production techniques, market forces, investment and support. In some countries, government realise the potential of the small-scale aquaculture sector, but in others basic provisions, such as a policy for aquaculture development, are still lacking.

CONCLUDING REMARKS

The decision to base the work in eleven partner countries, spanning three continents and a range of economic development situations, allowed testing hypotheses of impacts of aquaculture development on poverty and hunger across the spectrum of social, cultural and economic situations. The quality of the field data was as a result inevitably uneven, on occasion frustrating essential rigorous and quality analyses and drawing robust conclusions. Thus, while for the first time we have an integrated framework, tools and

indicators fit for purpose, we have not always been able to generate sufficiently strong data to fully test and develop the hypotheses underpinning our theory of how aquaculture can reduce poverty and hunger.

Despite this, and the shortcomings we mention, we conclude that aquaculture can reduce poverty and hunger. Specifically, fish farmers, fish farms workers and those involved in aquaculture are often economically better off than other food production sectors, households engaged in aquaculture generally have better income and consume more fish than others and that fish farming can alleviate poverty and improve food security in all but the poorest of the poor. However, the impacts of aquaculture are highly context specific.

Data analysis is not yet complete. Moreover, the above conclusions also largely ignore the impressive income multiplier effects that we found with aquaculture.

The following section summarises the societal implication of the AFSPAN project and a preliminary assessment of target audiences and key communication products.

THE POTENTIAL IMPACT AND THE MAIN DISSEMINATION ACTIVITIES AND EXPLOITATION OF RESULTS

INTRODUCTION

In this section we draw out the realized and potential social and economic impacts and wider societal implications of AFSPAN, describe what is being done to disseminate the results and set out our proposals for how they can be exploited to greatest effect with regard to reducing poverty and hunger.

SOCIO-ECONOMIC IMPACTS AND THE WIDER SOCIETAL IMPLICATIONS

We believe that the theory of change that underpinned AFSPAN still largely holds and that the frameworks, tools and indicators designed via the project have in the course of our analyses proved fit for purpose. That we were unable to always access or collect the data needed, and thus be in a position to fully accept or reject all the supporting hypotheses, is disappointing. With the benefit of hindsight, given the geographic scope of the project, the poor availability of quality, disaggregated fish production statistics and the sometimes uneven quality of the field data we were able to gather, this was inevitable. Thus, in addition to highlighting here the wider societal implications of our findings we also attempted to identify and prioritise knowledge gaps.

To date, AFSPAN has realized little impact on poverty and hunger: communications around the project mission and activities and preliminary results have largely been via the website, Facebook and sharing at stakeholder workshops. However, we have developed policy and other interventions that, if implemented, we believe will help aquaculture fulfil its promise.

Table 8 summarises the results and evidence we gathered, supporting or rejecting the hypotheses that underpin our theory of how aquaculture development reduces poverty and hunger.

Fish is important in food and nutrition security: We show – as do others[50] – that fish is important in the diets of the poor throughout much of Asia and Africa, forming a high proportion of animal source food intake. However, a dearth of disaggregated data confounds attribution of the impact of aquaculture on food and nutrition security[51]. Nevertheless, we believe that the evidence collected via the project is sufficiently compelling to recommend that fish in general and aquaculture in particular is incorporated into food and nutrition security policies, strategies and programmes.

[50] e.g. Beveridge *et al.* (2013), World Bank (2013), Longley *et al.* (2014), Waite *et al.* (2014).
[51] It is therefore recommended that countries collect disaggregated capture fisheries and aquaculture data (see also section below on knowledge gaps).

The importance of fish in improving the nutritional status of individuals, especially those at risk of malnutrition such as children and pregnant women, should be considered in nutrition programmes and promoted in discussions on food security and nutrition. Governments, with support from regional and international development organizations, should engage local, regional and international aquaculture sector entrepreneurs to support corporate social responsibility programmes focusing on food security and nutrition objectives and the support of small-scale fish farmers.

As with agriculture, the linkages between fish consumption and human health remain to be fully explored. How much fish, of what species and by what methods of culture (extensive or intensive), for example, is sufficient to meet the needs of vulnerable women and children during the first 1000 days? Is changing intra-household distribution of fish through education cost-effective and, indeed, effective at changing socio-cultural norms?

Aquaculture creates wealth and reduces income disparities, although evidence that it reduces poverty remains weak: Both immanent (e.g. economic growth) and interventionist (the development and implementation of policies to promote aquaculture development, improve governance and capacity) factors, as well as institutional arrangements, public-private partnerships and pioneering companies and individuals, were found to create enabling conditions for thriving aquaculture sectors. We found that while aquaculture can have significant positive impacts on such economic and social indicators as employment, GDP and homestead incomes and income distribution at national levels (i.e. Gini coefficient), insufficient evidence, in part because of sample size, was found to show that sector growth significantly reduces poverty (see also below). Nevertheless, there is now a strong case for aquaculture to be considered as part of national economic development strategies.

Table 8. Hypotheses underpinning the AFSPAN theory of change, the evidence collected during the project and its wider societal implications (see Section 2 above and the technical annexes).

Hypotheses	Evidence and societal implications
1. Fish is important in household food and nutrition security	• Seafood contributes >15% of animal protein consumed by 2.9 billion people worldwide. • Strong traditions of fish consumption are more apparent in Asia than elsewhere e.g. Bangladesh, where despite low per capita food supplies, fish represents a third of animal source foods consumed. • Although some disaggregated data were obtained, a dearth of such data, compounded by the lack of tools and indicators, continues to confound attribution of how support for the sector has improved food and nutrition security. • Recognising that fish is an excellent source of micronutrients, essential fatty acids and animal protein some case study countries (Bangladesh, Brazil, Chile, China, Kenya) recommend it be included in school meals once or twice per week.
2. Aquaculture can be an important driver of economic growth, sufficient to reduce poverty	• Fisheries and aquaculture directly employ 43.5 million people (2006), with 520 million people indirectly deriving their livelihoods from seafood-related activities. • The contribution of aquaculture to national GDP, excluding multiplier effects, ranged from negligible in countries with an emergent sector up to 5% or more of GDP in countries with a dynamic sector. • Multiplier effects (i.e. dollars generated at local level per dollar generated from aquaculture) were US$1.69 and US$1.3 at macro- and micro-economic levels, respectively. • Employment levels differed between commercial and small-scale producers. • Profits from fish farming and fish farming related incomes were often spent on locally produced goods or services, contributing to rural non-farm economic growth. • Market signals are better understood by larger, export-orientated producers. • Estimation of sector GDP elasticity of poverty shows that although aquaculture growth contributes positively to poverty reduction in some LIFDCs, the effect is not statistically significant.
3. Poor consumers purchase more fish when available and it meets their needs in terms of price and culturally determined preferences	• Strongest supporting evidence was found in Bangladesh.

Hypotheses	Evidence and societal implications
4. Improved access to information on fish, nutrition and health and changes in cultural and social norms will help ensure that vulnerable family members receive an equitable share of fish at mealtimes	• There is almost no integration of nutrition education with aquaculture programmes and no systematic, independent monitoring and evaluation of impact of aquaculture development on nutrition or health. • In Bangladesh, one project on aquaculture for household income and improved nutrition includes nutrition education and monitors household fish consumption. • Fairs and fish festivals and media based campaigns are being used in Bangladesh, Brazil, Chile, India and Nicaragua to promote fish consumption among the wider population.
5. Economic access increases when farmed fish is cheaper, the result of increased production and productivity and of more efficient value chains	• Aquaculture products were found to have suppressed global fish prices, increasing economic access for all but sometimes the poorest consumers. Impacts of value chain efficiency were not examined.
6. Aquaculture VC actors consume more of the fish they produce or trade and/or spend more aquaculture-derived income buying fish	• Fish consumption rates of households engaged in fish farming were, with the exception of the Philippines, found to be higher than national averages.
8. Export of aquaculture produce benefits national economies and does not impact negatively on national food and nutrition security	• The quantities of seafood exported from LIFDCs to developed countries approximate that of seafood imported by LIFDCs. • LIFDCs tend to export high-value seafood in exchange for less expensive although not necessarily less nutritious products. • Technical regulations, quality and composition standards, labelling, source and origin information requirements, and product differentiation, pose problems, especially for the small-scale sub-sector, in countries seeking to export aquaculture products.
9. Markets for aquaculture produce are strong and growing and its contribution to reducing poverty and hunger can be maximized if essential inputs are available and appropriate policies, technologies and entrepreneurial skills are in	• While enabling institutional conditions and arrangements and PPPs facilitate aquaculture development some also results from improvements in national economies. • Two main shortcomings were identified in restricting growth in aquaculture output: access to inputs and technical know-how and education.

Aquaculture can empower women and improve household nutrition: While a large number of women work in the aquaculture sector, their contributions are mostly unrecognized, unrecorded and undervalued, largely due to lack of collection of gender-disaggregated data. A further important finding with wide societal implications is that engagement of women in aquaculture improves their access to and control over resources and increases household consumption of fish. However, prevailing gender norms were often found to impede women's efforts to participate in aquaculture, especially when enterprise oriented, by restricting access to information and skills, limiting contact with other value chain actors and preventing them from spending sufficient time on aquaculture to ensure productive, profitable fish ponds.

It is thus important to explicitly include women in aquaculture initiatives and to identify and find mechanisms to effectively address social and cultural norms, including work load sharing, if the benefits on nutrition from aquaculture development are to be maximized. It is also recommended that FAO take the lead in preparing policy guidelines on gender equality, for example through technical guidelines on gender in aquaculture within the Code of Conduct on Responsible Fisheries.

Aquaculture can be a development option for the poor and socially marginalized: Poor people – those with least income and assets and who are often socially marginalized – are particularly vulnerable to external shocks (economic, climate change, etc.). In AFSPAN we found that the poorest were often able to benefit from aquaculture, either as producers or as employees, confirming findings from recent studies of the Tharu in Nepal and Adivasi people in Bangladesh[52]. The key to successful and sustained uptake of aquaculture by vulnerable people is an understanding of livelihoods and livelihood ambitions and the development of technical and business skills to help realize ambitions.

Aquaculture development can adversely affect the poor and socially marginalized: As with any development aquaculture can also have adverse social and ecological impacts. Adoption of aquaculture was found to sometimes lead to privatization of, or confer exclusive access to, common resources that are relied upon by socially marginalized groups (e.g. tribal and landless people, women) to sustain livelihoods. Aquaculture development sometimes aggravated tensions and promoted conflict, especially in Africa and the Indian sub-continent, resulting in poaching or vandalism. Such actions may also arise as a result of envy or 'social levelling', especially in Africa. Interventions developed within given specific socio-cultural contexts are most likely to lead to successful adoption and delivery of equitable development outcomes that do not aggravate social unrest. Aquaculture programmes need to include strategies for sharing benefits as widely as possible by adopting a community-based approach involving non-fish farmers in farm labour or other employment opportunities along the value chain created through increased fish production, thereby reducing the potential for conflict.

Aquaculture sustainability depends on good governance: Although not explicitly addressed in AFSPAN, our studies concluded that good aquaculture governance, which

[52] Bhujel *et al.* (2008), Pant *et al.* (2013); Stepan (2013)

reconciles ecological with human wellbeing, is essential to ensure its sustainability[53]. Governance broadly encompasses institutions, policies, legislations and processes. Among regulations affecting social wellbeing are minimum wages, prohibition of child labour, and conditions of work, factors that have an effect on food security and nutrition aspects. Governments should assess policies, interventions and investments with direct and indirect links to aquaculture, fisheries and fishing communities to ensure positive impacts on the right to food.

Sustained uptake of aquaculture depends on technical and business skills and strong market linkages: Aquaculture was found to be more prevalent in communities where fish is of socio-cultural significance and where there are both indigenous technological knowledge and the skills and resources for aquaculture to help fulfil livelihood ambitions. This is important, given the growing geographic disparities between supply and demand, especially in sub-Saharan Africa. Households adopting aquaculture were found to quickly assess costs and benefits versus other livelihood options, such as crop or livestock farming or off-farm employment, especially when project subsidies are removed, before deciding whether to sustain adoption. Groups, cooperatives and clusters facilitating connections to markets were also found to help sustained uptake.

More support is thus needed to grow smallholder aquaculture in areas lacking tradition. Aquaculture must meet livelihood objectives, farmers need to have the skills – technical and business – to be able to sustain uptake, and some form of cooperative or producer organisation that can quickly identify and disseminate best practices and facilitate good linkages to upstream and downstream markets is desirable.

International seafood trade has implications for food and nutrition security: The quantities of seafood exported from developing to developed countries were found to approximate those of seafood imported by developing from developed countries, implying that trade is largely neutral in food and nutrition security terms. However, small-scale, informal producers and traders (mainly women) are often marginalized by globalization of fish trade and policies and interventions to protect their interests are often needed.

The growing gap between supply and demand in Africa in particular is unlikely to be met by trade due to a combination of escalating real prices and insufficient income growth[54]. It is thus recommended that much greater attention is paid to aquaculture in areas where fish is important in diets but where the deficit between supply and demand is growing.

Aquaculture must change if it is to appeal to rural youth: The average age of farmers in LIFDCs is increasing, as most youths seek better paid and less physically demanding employment. Nor do parents encourage offspring to become farmers[55]. Older, less educated farmers are also less likely than the young to adopt new technology[56]. One way

[53] Hishamunda *et al.* (2014)
[54] see also Fishing for a Future (2013a), Béné *et al.* (2014).
[55] see, for example, FAO (2014b).
[56] see e.g. Yin. 1990.

to address the issues is to make aquaculture more profitable and less labour intensive by intensifying production through farming genetically improved strains of higher value species, use of quality seed and more environmentally friendly, high quality and affordable feed, and better management. This broadly aligns with the aims of certification bodies trying to raise environmental and ethical standards in aquaculture production[57].

There is a lack of joined up policy thinking on aquaculture: As has been observed elsewhere[58], policies to reduce poverty and hunger linked to those promoting the development of aquaculture are found in very few countries.

KNOWLEDGE GAPS

Despite the above findings there remain substantive knowledge gaps that prevent a comprehensive understanding of some of the wider economic and socio-cultural implications of the project. It should also be noted that some of the knowledge gaps are due to the fact that not all project data have yet been fully analysed.

The focus for future research should be sub-Saharan Africa and the Indian sub-continent: here, aquaculture is least developed, most of the world's poor reside and the gap between fish supply and demand is large and growing[59]. Socio-cultural, institutional and technical reasons underlying the success of aquaculture in Asia should continue to be explored to determine any lessons that might usefully be applied in Africa and South Asia. Among the main knowledge gaps we identify are:

Aquaculture and poverty reduction: While we found that aquaculture can significantly impact on such economic and social indicators as employment, GDP and homestead incomes, and income distribution at national levels better – i.e. more rigorously collected and disaggregated between aquaculture and capture fisheries - datasets are needed to rigorously test the hypothesis that sector growth significantly reduces poverty.

Economic multipliers: Estimates were made of the economic multipliers associated with the goods and services procured using incomes derived from aquaculture (i.e. consumption linkages). These can be extremely important in terms of impacts on local economies and on poverty alleviation. Despite present research they remain poorly understood in an aquaculture context.

Nutrition education and fish consumption by vulnerable individuals: The impacts of nutrition education on fish purchases and on intra-household distribution of fish among poor and socially marginalized people were not tested in AFSPAN.

Fish consumption and health linkages: Links between species, farming methods and

[57] e.g. Farmers in Transition Fund (http://www.fitfund.com/en/home), Aquaculture Stewardship Council (http://www.asc-aqua.org/)
[58] Beveridge *et al.* (2010)
[59] see also Allison (2011), World Bank (2013).

fish nutrient content and between farmed fish consumption and health remain poorly understood.

International trade in aquaculture products, food and nutrition security: AFSPAN confirmed that the international trade of seafood does not necessarily undermine food security, although it was not possible in the present study to determine how developing countries use the income from seafood exports. Future research should address this issue.

Trade-offs between aquaculture and other economic activities: While recognized, the trade-offs between use of ecosystem services to support aquaculture rather than for other purposes was not explored. In Bangladesh, for example, we discovered that aquaculture can simultaneously improve food security of producers while eroding that of (often poorer) non-producers. Further research taking into account effects operating at a range for scales, is required in order to obtain a more complete understanding of the issues.

Environment and climate change: Among the key considerations here is the development of more productive aquaculture strains, sustainable feeds and climate change.

While trade and commercial interests generally drive genetic improvement programmes, the need to improve food and nutrition security should also be a driver. The genetically improved farmed tilapia (GIFT) programme demonstrates that a food and nutrition security approach to breeding can generate substantial growth in aquaculture development, benefiting both producers and consumers. Further research on small micronutrient-rich fish (‘mola’; *Amblypharyngodon mola)*, which has shown encouraging results in Bangladesh, is also needed.

Governments, international development organizations, research institutes and the private sector need to work together to further reduce the use of fishmeal and fish oil in fish feeds. Much of the small pelagic fish used to produce these products is edible and can contribute to food security and nutrition, although markets for such fish species remain poorly developed. The culture of fish that feed low in the trophic food web (herbivores and omnivores) must also be promoted.

Aquaculture, like other food sectors, is vulnerable to climate change. It is essential that governments mainstream climate change adaptation strategies into fisheries and aquaculture policies, strategies and programmes.

MAIN DISSEMINATION ACTIVITIES AND EXPLOITATION OF RESULTS

Recognizing the potential of aquaculture to meet future demands for fish, the global community has been designing and developing new initiatives, such as the FAO-led Global Aquaculture Advancement Partnership (GAAP) and the World Bank championed Global Partnership for Oceans (GPO). Governments, international and regional development organizations, civil societies and the private sector need to ensure that such initiatives take into account food security and nutrition aspects based on the recent knowledge, including that provided by the AFSPAN project.

The AFSPAN project has generated much new information and tools that can help sharpen and focus debates and initiatives. The target audiences for AFSPAN outputs thus include governments, donors and the private sector (POs, investors), in thereby helping build a shared understanding of how aquaculture can reduce poverty and hunger, the conditions under which aquaculture is likely to thrive, and where investment in research is most needed.

A range of communication products is under development, including the project web-page (http://www.afspan.eu/modules/news/article.php), policy briefs, papers, conference presentations and articles. Almost all country partners are either national academia or national government competent authorities; thus, it is expected that the outcome of the project and the policy messages will be incorporated into national development plans and programmes.

A preliminary summary of publications and other media dissemination activities carried out to date or underway is presented in Table 9.

Table 9. Preliminary list of dissemination activities

Country/region	Development theme	Initiative
Global		
	General	• Main findings and policy and development advice will be presented to the 8th Session of the FAO Committee on Fisheries Sub-Committee on Aquaculture, Brasilia, October 2015, under the patronage of the Government of Brazil. Recommendations on future work and follow up action will be generated through discussion at the Session. Recommendations and advice will be disseminated to all FAO member countries, relevant NGOs, IGOs and development partners by mid-2016. • A series of policy briefs has also been drafted, including: o Brief: Towards a more comprehensive understanding of aquaculture development and its impacts on poverty and hunger. o Brief: Recommendations for best practice in aquaculture development. o Brief: Sociocultural factors affecting aquaculture development.
	Food and nutrition security	• Nutrition-sensitive aquaculture, based on "Key recommendations for improving nutrition through agriculture and food systems" is being promoted (http://unscn.org/files/Agriculture-Nutrition-CoP/Agriculture-Nutrition_Key_recommendations.pdf). Based on the findings from Bangladesh, nutrition-sensitive aquaculture will be scaled out by WorldFish and partners in selected countries. • The Second International on Nutrition (ICN2) Framework for Action focuses on sustainable food systems: sustainable healthy diets, nutrition education for behaviour change and the need for appropriate, integrated and sustainable production systems for fish for increased consumption, especially in vulnerable population groups, including women and young children (http://www.fao.org/fsnforum/sites/default/files/files/107_ICN2-FFA/ML079_ICN2_FfA_en.pdf). A background paper has been produced: • Thilsted S.H., James D., Toppe J., Subasinghe R., Karunasagar I. 2014. Maximizing the contribution of fish to human nutrition. Background paper. ICN2 Second International Conference on Nutrition. http://www.fao.org/about/meetings/icn2/preparations/document-detail/en/c/242589/. • The following policy briefs has also been drafted: o Brief: Aquaculture for Better Nutrition and Health – the Role of Nutrition Education.

Country/region	Development theme	Initiative
Asia		
	Food and nutrition security	• A special AFSPAN issue of the NACA email newsletter is in preparation, focusing on key messages, findings and providing links to the reports. The newsletter is distributed to >3,000 people worldwide. • An article on the project findings will be published in the NACA Newsletter (a separate, printed publication) distributed to around 2,000 people worldwide. • A special presentation on the key messages from the project will be presented to the 12th Session of the NACA Technical Advisory Committee Meeting (March 2015), identifying priorities and informing NACA's next five-year work plan (2015-2020). • A special presentation on the key messages from the project will be presented to high-level policy makers at the 26th Session of the NACA Governing Council Meeting (Bali, Indonesia, May 2015). The Governing Council comprises representatives of 19 member governments in the region, which produce around 88% of global aquaculture output by volume. • A short video documentary on the project and its findings will be prepared by NACA for dissemination on the NACA Website and via partner websites.
Bangladesh	Food and nutrition security	• Belton B, Ahmed N & Murshed-e-Jahan K. 2014. Aquaculture, employment, poverty, food security and well-being in Bangladesh: A comparative study. Penang, Malaysia: CGIAR Research Program on Aquatic Agricultural Systems. Program Report: AAS-2014-39. http://www.worldfishcenter.org/resource_centre/AAS-2014-39.pdf. • AFSPAN findings in Bangladesh were published in the latest volume of Fisheries and Aquaculture News (FAN). http://bfrf.org/fanbangladesh/FAN%20newsletter%20Vol%202%20Num%202.pdf

Country/region	Development theme	Initiative
China		• AFSPAN project outputs and findings will be published in technical papers and journals in English and Chinese, so as to facilitate dissemination among development partners and the EU. • As the national research institute, Freshwater Fisheries Research Center will disseminate the projects results and findings to high-level fishery authorities, such as the Ministry of Agriculture and the Fishery and Administration Bureau, as well provincial governments, so as to help inform decision making on aquaculture development, nutrition education programs and trade and regulation. • FFRC will publish project results from China in scientific journals in order to help raise awareness of the potential role of aquaculture in poverty alleviation, food and nutrition security. • FFRC will integrate the research results of the project in training materials for PhD, MSc and BSc student, as well as the trainees from developing countries, helping promote the importance of aquaculture development in China and the world, especially in terms of food and nutrition security. • FFRC will play a critical role in scientific research, training and education, information sharing and technical transfer in global and home perspectives. FFRC and other research institutions and organizations will conduct more projects focusing on aquaculture and food and nutrition security and poverty alleviation, so as to promote the sustainable development of aquaculture.
India	Food and nutrition security	• Project findings will be disseminated through workshops and meetings with relevant stakeholders. Government of India will be advised to include fish in public nutrition programmes and in school meals programmes. Government will also be advised to undertake promotion of fish consumption through fairs, fish festivals and media based campaigns. Steps will also be initiated towards encouraging sustainable aquaculture through the formulation of schemes promoting private participation in cold chains development to help increase the availability of fresh fish and increase per capita consumption.
Africa		
Ghana	Food and nutrition security	• Kassam, L. 2014. Aquaculture and food security, poverty alleviation and nutrition in Ghana: Case study prepared for the Aquaculture for Food Security, Poverty Alleviation and Nutrition project. WorldFish, Penang, Malaysia. Project Report: 2014-48. http://pubs.worldfishcenter.org/resource_centre/2014-48.pdf.
South America		
Chile	Food and nutrition security	• A paper is currently in preparation on the role of fish in school feeding programs in tackling over-nutrition.

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ANNEX 1. AFSPAN PARTNER DETAILS

Technical partners

WP Number	WP Title	Type of activity	Lead partner	Logo	Contact person	Address	Email
WP1	Project management	MGT	FAO	Food and Agriculture Organization of the United Nations	Rohana Subasinghe	Viale delle Terme di Caracalla, 00153, Rome, Italy	Rohana.Subasinghe@fao.org
WP2	Assessment methodologies, indicators and framework	COORD	IDS	IDS Institute of Development Studies	Christophe Bene	Brighton Falmer, BN1 9RE U.K.	c.bene@ids.ac.uk
WP3	Review and assessment of national and international cooperation	COORD	FAO	Food and Agriculture Organization of the United Nations	Rohana Subasinghe	Viale delle Terme di Caracalla, 00153, Rome, Italy	Rohana.Subasinghe@fao.org
WP4	Sustainable aquaculture systems and institutions	COORD	WorldFish	WorldFish	Benjamin Belton	House 22B, Road 7, Block-F, Banani, Dhaka 1213, Bangladesh	B.Belton@cgiar.org
WP5	Social and cultural factors affecting aquaculture	COORD	WorldFish	WorldFish	Jharendu Pant	Jalan Batu Maung, Batu Maung 11960 Bayan Lepas Penang, Malaysia	J.Pant@cgiar.org

WP Number	WP Title	Type of activity	Lead partner	Logo	Contact person	Address	Email
WP6	Nutrition education in aquaculture	COORD	Copenhagen University		Nanna Roos	Department of Human Nutrition Rolighedsvej, 30, Frederiksberg C, 1958. Denmark	nro@nexs.ku.dk
WP7	Trade and markets	COORD	Portsmouth University		Frank Asche	Kjell Arholmsgate 41, Stavanger 4021 Norway	frank.asche@uis.no
WP8	Synthesis, policy guidance and coordinating arrangements	COORD	FAO		Rohana Subasinghe	Viale delle Terme di Caracalla, 00153, Rome, Italy	Rohana.Subasinghe@fao.org
WP9	Communications and dissemination	OTHER	NACA		Simon Wilkinson	Suraswadi Building, Department of Fisheries Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900 Thailand	simon@enaca.org

Country partners

Country	Organization	Logo	Contact person	Address	Email
Bangladesh	Bangladesh Fisheries Research Forum		Mostafa Hossain	Department of Fish. Biology & Genetics Bangladesh Agricultural University Mymensingh-2202 Bangladesh	marhossain@yahoo.com
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India	Ministry of Agriculture		Vishnu Bhat	Krishi Bhawan, Dr, Rajendra Prasad Road, New Delhi 110 001 India	bhatbvishnu@gmail.com
Philippines	Southeast Asian Fisheries Development Center/Aquaculture Department		Felix G. Ayson	Tibauan, Iloilo, 5021 Philippines	fgayson@seafdec.org.ph
Viet Nam	Research Institute For Aquaculture No.1		Phan Thi Van	Ministry of Agriculture and Rural development (MARD) Dinh Bang, Tu Son, Bac Ninh Viet Nam	phanvan@ria1.org;

Country	Organization	Logo	Contact person	Address	Email
Kenya	Ministry of Agriculture, Livestock and Fisheries, State Department of Fisheries		Beatrice Nyandat	Museum Hill, P. O. Box 58187-00200 Nairobi, Kenya	tieny30@yahoo.com;
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Brazil	Instituto De Ciencais Do Mar Da Universidade Federal Do Ceara		Alberto J.P. Nunes	Av. da Abolição, 3207 – Meireles 60.165-081 Fortaleza, Ceará, Brazil	albertojpn@uol.com.br
Chile	Pontificia Universidad Catolica De Valparaiso		Exequiel Gonzalez P.	Escuela de Ciencias del Mar Pontificia Universidad Catolica de Valparaiso Av Altamirano 1480, Valparaiso Casilla 1020, Valparaiso, Chile	exequiel.gonzalez@ucv.cl;
Nicaragua	Universidad Centroamericana, Centro De Investigación De Ecosistemas Acuáticos		Juan Ramon Bravo Moreno	CIDEA, Rotonda Ruben Dario 150 metros aloeste, Managua, 69, Nicaraua	jbravo@ns.uca.edu.ni;

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SEVENTH FRAMEWORK PROGRAMME