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AFSPAN Work Package 4

Synthesis report including best practice recommendations

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Table of Contents

SYNTHESIS REPORT FOR THE AQUACULTURE FOR FOOD SECURITY, POVERTY ALLEVIATION AND NUTRITION PROJECT, WORK PACKAGE 4: SUSTAINABLE AQUACULTURE SYSTEMS AND INSTITUTIONS

Introduction

Work Package 4 of the Aquaculture for Food Security Poverty and Nutrition (AFSPAN) project, titled *'Sustainable Aquaculture Systems and Institutions'*, was designed to elicit a better understanding of the role of aquaculture systems, scale, enterprise structure and institutional arrangements in improving rural livelihoods. Specifically, the objectives of the work package were to:

(1) Assess financially viable entrepreneurial aquaculture activities including small-scale operations and their contribution to poverty alleviation and food security.

(2) Identify enabling institutional conditions and arrangements for food security and poverty alleviation.

(3) Identify successful public-private partnerships contributing to aquaculture development in developing countries.[1]

Nine project partners submitted country case studies for Work Package 4 (Brazil, Chile, China, Guatemala, India, Kenya, Philippines, Uganda and Vietnam). These were augmented by two more intensive in depth case studies from Bangladesh and India, and a third case study of Ghana commissioned externally to the project by WorldFish, but covering similar ground, and included here for comparative purposes. Following sections of this report outline: 1) the case study methodology adopted; 2) the analytical framework with which the data collected was analyzed; 3) case study results, presented as two subsections on the impacts of aquaculture on poverty and food security, and the enabling conditions, institutional arrangements and public-private partnerships contributing to aquaculture development; 4) conclusions. A summary of key finding from each case study is presented in tabular form in Annex 1.

Case study methodology

The purpose of each case study was to provide a clearer understanding of conditions and arrangements which enabled, or prevented, the development of aquaculture systems that alleviate poverty, reduce food security, or improve nutrition. Aquaculture systems are characterized by the species farmed, the intensity of production, the scale of production, and production environment (ponds, cages, tanks, etc.)[2]. Enabling conditions and arrangements can originate from the public sector, from the private sector, or from interactions between the two.

Aquaculture can contribute to poverty alleviation and food and nutrition security directly or indirectly. The adoption of small scale fish culture may reduce poverty and food insecurity directly by raising farm incomes and increasing consumption of nutritious fish. The development of commercial aquaculture may reduce poverty indirectly (e.g. by creating well-paid jobs), or increase food security indirectly (e.g. by reducing the price of fish available in the market, thus

[1] Here we consider to the term 'public-private-partnership' in a broad sense. These can be formal arrangements, such as the government providing funding for construction of a private farm, or informal arrangements, such as a public sector employee working as a consultant outside of office hours.

[2] Examples of aquaculture systems include: small-scale, semi-intensive carp polyculture; Large-scale intensive tilapia cage culture; Intensive pangasius pond culture; Small-scale integrated freshwater prawn and rice farming.

allowing poor households to consume more). The aquaculture system chosen for the case study should alleviate poverty or enhances food and nutrition security (directly or indirectly), and the case study should provide evidence of this.

Each case study identified conditions and arrangements which had contributed to (or prevented) the development of aquaculture systems that alleviated poverty, or which improved food and nutrition security. Conditions or arrangements may be enabling or disenabling for aquaculture development. Case studies were intended to consider both positive and negative examples, where relevant.

All country partners were experts on aquaculture development in their respective countries, and possessed lot of 'tacit' (unwritten) knowledge which was drawn upon to help complete the case studies. The existing knowledge and experience of country partner institutions was therefore one of the most important sources of information used to complete each study. This knowledge was supplemented by interviews with carefully chosen key informants, and/or through informal discussions with colleagues or other actors with a good understanding of the aquaculture system in question. The case studies also incorporated supporting secondary information (e.g. from policy documents, project reports, government statistics, academic papers). Each country case study was comprised of four sections:

1) A brief description of the aquaculture system which was the focus of the case study. (e.g. the geographical location, the species farmed, the system productivity (tonnes/ha) and investment costs (USD/ha), typical farm size (ha), feeding practices; the production environment (cages, ponds, etc); employment generation; the main market (e.g. rural/urban, domestic/international, high value/low value); the main people and institutions involved (men/women, poor farmers, wealthy investors, companies, co-operatives etc.)

2) An assessment of the contribution the system makes to poverty alleviation/food & nutrition security. Key questions to be answered related to the main contributions of the system in terms of poverty alleviation and/or food and nutrition security, including whether they were direct or indirect (to producers, to consumers, to employees, etc.). Quantitative evidence of these effects was included where possible (e.g. numbers of jobs created, average incomes generated)

3) An analysis of the key conditions and arrangements which have made the development of this aquaculture system possible, or constrained its development. Examples of the most important conditions and arrangements that facilitated or constrained the development of this aquaculture system were provided, along with explanations of why were they important, whether they originated from the public sector or the private sector, whether they were formal (planned), or informal (unplanned), and whether and in what ways interaction between the public and private sector played any role in the sector's development

4) A summary of the most important lessons from the case study with respect to how and why the conditions and arrangements identified contributed to poverty alleviation or improved food security and nutrition outcomes.
Case studies provided by country partners were presented in summarized form at the final project meeting in Nairobi in September 2014, along with summaries of findings from three in depth case studies conducted in Bangladesh, India and Ghana. This enabled partners to comment on the

representation of their case studies, to correct any misinterpretations which had occurred, and to provide additional information. It was decided that presenting the most important themes apparent from each of studies would be the most effective way of communicating and comparing key findings. A concise summary of key points is also provided in Annex 1. Table 1 lists the subject of each of the nine short and three in-depth country case studies. As the summary suggest, these cover a very wide range of aquaculture systems in terms of geographical location, species, culture environments, scale, institutional context, and social organization of production. The intention in selecting these cases was not to attempt to provide a representative mixture of production systems, but to present unique cases reflecting a broad diversity of characteristics in the hope of identifying underlying commonalities.

Table 1: Case study summary

Country	Case description
Bangladesh	Compared six production systems (small-scale carp polyculture, intensive pangasius, extensive tiger shrimp, integrated giant freshwater prawn) in three districts, in terms of the ability of poor and landless households to participate as producers, the nature and extent of employment generation and effects on local food security
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 Northeast Brazil
Chile	Detailed the institutional factors enabling and disabling development of blue mussel and Gracilaria algae aquaculture practiced in at a range of scales and contributions to employment, incomes and food security
China	Documented the effects of agro-cooperative formation on the production and marketing of black carp in Wuxi
Ghana	Compared the economic multiplier effects associated with small and medium scale commercial tilapia cage culture and small-scale pond culture in Ghana
India 1	Examined Government of India scheme to promote culture based fisheries in nine reservoirs in Chhattisgarh and Jharkhand states as a means of alleviating poverty among disadvantaged fisher communities.
India 2	Documented dramatic growth of pond based semi-intensive Indian major carp and intensive pangasius farming Andhra Pradesh
Kenya	Described the effects of a sustained government program to stimulate the development of small-scale aquaculture throughout Kenya via pond construction, provision of production inputs and services, and the promotion of fish consumption
Nicaragua	Evaluated the institutional strengths and weaknesses of women's shrimp farming cooperatives in the Occident region of Nicaragua and their successes and failures
Philippines	Explored the role of the public and private sector in stimulating small-scale seaweed farming in Bohol and Guimaras provinces and the livelihoods of seaweed producers
Uganda	Assessed the geographically mixed results of government promotion of small-scale pond aquaculture throughout Uganda and identifies factors associated with successful aquaculture development
Vietnam	Examined the effects of a government decree allowing farmers to convert low productivity low-lying rice paddies into aquaculture in Bac Ninh province

Analytical Framework

Aquaculture has attracted considerable interest as a vehicle for reducing poverty and food insecurity, and a variety of pathways via which 'the poor' might gain from the growth of aquaculture have been identified. The most important potential benefits stem from improved food supply and/or employment and increased incomes. These are summarised in Figure 1. Benefits may be accessed directly (i.e. by a producer of farmed aquatic products), or indirectly (e.g. through employment in aquaculture value chains, or through increased availability of low-cost fish in local markets) (Edwards, 1999). Ahmed and Lorica (2002) emphasise 'income linkages', 'employment linkages' and 'consumption linkages' as means by which aquaculture can improve food security and reduce poverty. Again, these may be direct (e.g. sale and consumption of self-produced fish by farm households), or indirect (e.g. elasticity effects associated with rising incomes for households adopting aquaculture, and reduced prices due to increased fish supply for consumers). Similarly, Stevenson and Irz (2009) identify entry into aquaculture by new producers, employment on fish farms and in upstream and downstream value chains, and increased supply of fish for consumption by the poor as pathways via which aquaculture may contribute to poverty reduction. A final indirect pathway relates to the 'consumption linkages' generated by re-spending of income gained from sales of farmed fish on locally produced 'non-tradable' goods and services (Delgado et al, 2003; Kassam, 2013).

Figure 1 Common features in explanations of the contribution of aquaculture to poverty reduction (Source: Toufique and Belton, 2014)

	Consumption		
	• Increased consumption of fish from own production	• Increased availability of fish in markets • Increased accessibility of fish due to reduced prices	
Direct	• Increased incomes from entry into aquaculture or increased returns from existing production	• Employment on fish farms • Employment in up and downstream value chains • 'Consumption linkages' in the rural non-farm economy	**Indirect**
	Income		

Discussion in the first half of the results section is organized according to this framework. The nature of direct consumption linkages (increased fish consumption by producers), direct income linkages (increased incomes and improved living standards, both intra- and intergenerational), indirect consumption linkages (increases in fish consumption taking place at regional or national level), and indirect income linkages (employment generation for women and men, economic

multiplier effects, and impacts on local economies) are all explored with reference to examples from the country case studies.

The second half of the results section addresses enabling conditions for aquaculture development. According to Morse (2008, p341) 'development has two forms. 1. Immanent development (or what people are doing anyway): a broad process of change in human societies driven by a host of factors including advances in science, medicine, the arts, communication, governance etc. 2. Intentional (or interventionist) development: a focussed and directed process whereby government and nongovernment organizations implement projects and programmes to help develop the under-developed. Both occur in parallel, with immanent development as a canvass of change in societies and intentional development as planned interventions'. This distinction is adopted here in order to distinguish between intentional or planned efforts to stimulate aquaculture development, and ongoing processes which emerge 'organically' in response to market signals and opportunities (Belton and Little, 2011). Interventionist forms of development can be seen as 'supply driven', where conscious attempts are made to increase the volume of aquaculture or aquatic products available, with immanent development broadly 'demand driven', arising in response to specific economic needs and opportunities.

Several additional subthemes emerged from comparative analysis of the case studies. One representative case is presented in detail for each of the subthemes. With respect to interventionist forms of development, case studies on the following topics are presented: 1) state-led attempts induce the uptake of aquaculture through training and other promotional efforts, 2) efforts to stimulate aquaculture development via sector-specific policy interventions; 3) examples of how enabling governance environments have supported sectoral growth; 4) successful public-private partnerships. With respect to immanent development pathways, case studies illustrate the role of 1) export markets in creating opportunities for development; 2) the importance of domestic markets, the emergence of which is often related to capture fisheries decline and growth in incomes, in stimulating aquaculture development; 3) instances where the technical or institutional innovations of pioneering companies or farmers created new opportunities for sectoral growth. In reality, these two sets of processes do not occur in isolation, as all interventions necessarily take place against a backdrop of ongoing processes of social and technical change and development within the wider economy. The final segment of the subsection therefore presents a case addresses synergies and overlaps between immanent and interventionist processes, and highlights complementarity between the two.

Results

Impacts on poverty and food security

Direct consumption linkages

Case studies from India (Chhattisgarh and Jharkhand), Kenya, Uganda, Ghana and Bangladesh all point to elevated levels of fish consumption among fish producers. This evidence supports the results of studies such as those by Jahan et al (2010) and Ahmed and Lorica (2002) which presented empirical and conceptual evidence that uptake of, or increased production from, aquaculture is correlating to increased levels of home consumption of fish. Specific examples taken from the case studies are provided below.

- **India (Chhattisgarh and Jharkhand):** A reservoir stock enhancement scheme introduced by the Government of India, under which the fish catch is shared among fishers, fishers' cooperative societies and the government, at the ratio of 50:30:20, has increased fish consumption rates among participating fisher communities by 60%.
- **Bangladesh:** On average, members of aquaculture producer households in Bangladesh operating a variety of farming systems consumed more fish than members of households not practicing aquaculture. Self-produced fish consumed by aquaculture producers tended to augment supplies of fish sourced from the wild and/or purchased from the market, rather than replacing them. In addition, contrary to expectations, commercially oriented smallholder aquaculture producers consumed larger quantities of fish from their own farms than households operating subsistence-oriented fish production systems (e.g. operators of integrated giant freshwater prawn farms consumed 44 g of fish/capita/day, whilst homestead pond operators consumed 27 g of fish/capita/day). On average, Individuals from households practicing aquaculture consumed (and produced) more rice, fruits, non-leafy vegetables and fish per capita on average, than those that did not. However, this reflected the higher-than-average incomes and larger-than-average agricultural landholdings of the former group, rather than any direct causal link to aquaculture production.
- **Uganda:** The dominant fish production system in Uganda is also small-scale production of catfish and tilapia in earthen ponds. 60% of the 12 000 farmers estimated to be involved in aquaculture have ponds with a total surface area of 50 m^2 to 200 m^2, and practice subsistence production, providing an important source of fish for homes consumption by producer households. Most sales from more commercially managed ponds are to surrounding communities. Aquaculture therefore directly contributed to the nutrition and food security of producing communities
- **Kenya:** Since the initiation of the government's flagship Fish Farming Enterprise Productivity Programme (FFEPP), the average productivity of semi-intensively managed earthen ponds used to culture Nile tilapia and African walking catfish has increased from 1-3 t/ha/year to 3-8 tonnes/ha/year. This change is thought to have increased levels of household fish consumption among fish farmers.
- **Ghana:** In Ghana, poor fish farmers in the Ashanti Region producing tilapia and African walking catfish in small ponds sold over 60 percent of their harvest, consuming and gifting the remainder, while non-poor farmers sold nearly 80 percent of their harvest. Although, 60% of farmers surveyed reported that fish farming had increased fish for home consumption, a survey by Kassam (2013) found little difference in the frequency of

fish and meat consumption among fish farming and non-fish farming households. Comparison of Food Consumption Indices based on dietary diversity and frequency of consumption also showed very little difference in food security between fish and non-fish farming households, suggesting that this type of aquaculture had limited direct impacts food security. However, a small difference was found in terms of food vulnerability (the ability of household heads to provide adequate food) with fish farming households being slightly better off than non-fish farming households.

Summary: The examples provided above 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, as classically identified in the literature, but also extends to fishers benefitting from stock enhancement programs, and commercial smallholder aquaculture producers who, in Bangladesh, were found to consume greater quantities of self-produced fish than their subsistence oriented counterparts. However the example from Ghana 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

Toufique and Belton (2014) have 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 associated with aquaculture, whilst important, are finite and geographically concentrated. They conclude that aquaculture therefore 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 accessibility of fish and lowers fish prices relative to those of other animal source foods. Examples taken from the case studies below present evidence on the indirect consumption effects of aquaculture

- **Kenya:** Reported fish production from aquaculture increased from 4 250 tonnes in 2007 to 21 487 tonnes in 2012, thereby increasing the availability of fish from aquaculture nearly five-fold in 4 years. This may be inferred to have had knock on effects for the nutritional status of rural communities because fish is cheaper on average than (USD2.9/kg) than meat (USD3.9/kg). A note of caution must be sounded in interpreting these results however, as it is not clear whether fish at this price is accessible to the poorest.
- **India (Chhattisgarh and Jharkhand):** Stock enhancement in nine reservoirs resulted in the production of an additional 3213 t of fish. However, the fish stocked were Indian Major Carps, which fetch a high market value. The average price of fish harvested was 55% higher than that of unstocked fish harvested. Although this was clearly beneficial for the fishers involved, it is less clear whether this increase would have resulted in gains for poorer consumers.

- **India (Andhra Pradesh):** Andhra Pradesh (AP) achieved estimated freshwater finfish production of 1.47 million metric tonnes in 2012. It thus contributes about 60% of India's total farmed fish**.** For cultural reasons, consumption of freshwater fish is limited in AP, so the contribution to local food security is rather limited. Most of the fish produced is marketed through Kolkata to states, including West Bengal, Bihar, Uttar Pradesh, Assam

and elsewhere in the Northeast, meaning that fish production in AP makes important impacts at the national scale. The sheer scale of farmed fish production in AP makes a major contribution to national fish supplies and has significantly reduced real freshwater fish prices. For instance, the retail price for carps in West Bengal during the 1980s was Rs130-150/kg; a similar level to the farm gate value of carps in 2012, suggesting that a very substantial reduction in real (inflation adjusted) price of farmed fish occurred over this period.

An analysis of national demand for fish in India, Kumar et al (2005, p181) found that 'technological development has lowered the production cost (at constant prices) per unit of fish and made available additional fish at cheaper prices to the consumers and improved their nutritional security'. As AP accounts for a large share of national production and has been at the forefront of technological developments in aquaculture it can be inferred that aquaculture development there has contributed to national food and nutrition security. However, as in the Chhattisgarh and Jharkhand case cited above, it is unclear whether the price reductions achieved have been is sufficient to put these fish within the purchasing power of poor consumers, and more detailed studies are required to obtain a more fine-grained picture of the size and nature of these contributions and the precise nature of impacts on food and nutrition security.

- **Ghana:** Communities benefit greatly from cheaper and increased supply of fresh fish when fish ponds are harvested. Fifty seven percent of all respondents surveyed by Kassam (2013), a sample which included by fish and non-fish farmers, indicated that aquaculture had increased fish supply in their communities, although interviews also suggested that the poor benefitted less than the non-poor from increased local fish supply. In addition, the small number of pond farms operating in villages at present and the long periods between harvests (with production cycles typically ranging from 6 months to 2 years), means that harvesting, and thus increases in local fish supply, are infrequent. However, as households spend a significant proportion of their cash income on fish, the potential for increased adoption of small-scale pond aquaculture in rural communities to increase fish supply, reduce prices and impact on local food security and increase real income is strong. SME and large-scale cage farms produce fish in much larger aggregate volumes than pond farms, but these are usually sold to urban areas, rather than to communities located around the farms and thus do not contribute much to localised rural increases in supply or reductions in price. Increased fish supply is likely to impact poor consumer unless prices fall to a level which they can afford. Tilapia is generally a high value fish in Ghana, demanded by better off consumers, and there is very high demand for all fish due to very substantial production deficits. Therefore, increased supply of tilapia will not necessarily lower its price, or benefit poor consumers, over the short term.

- **Bangladesh:** The study in Bangladesh compared the 'household food insecurity access' (HFIA) scores of aquaculture producer and non-producer households in villages with high concentrations of different types of aquaculture. (Scores were derived from responses to a questionnaire module designed to measure household food insecurity, the results of which provide generate indexed value. A higher value equates to greater food insecurity.) The HFIA scores of 'non-aquaculture' households were more than twice those of aquaculture producers (1.8 versus 4.1) in villages where many smallholders

practiced commercial pangasius farming. A similar but more acute pattern was apparent in villages where more than half of households farmed freshwater prawn or tiger shrimp. The food insecurity scores of 'no aquaculture' households were extremely high (8.8 and 7.8 respectively), exceeding those of households engaged in aquaculture by a factor of nearly three. There was also a large difference in the HFIA scores of aquaculture producers (2.4) and 'no aquaculture' households (6.1) in one of the two villages with little commercial aquaculture. These results seem to imply two possibilities: at community level, widespread involvement in commercial smallholder aquaculture either had the effect of reducing average levels of food insecurity, or of increasing inequality in access to food and exacerbating the food insecurity of those unable to participate as producers. Both scenarios appear plausible, and may in fact operate simultaneously with, for instance, households able to engage in aquaculture benefitting from substantially increased incomes which translate into greater food security, and households unable to do so experiencing declining food security as a result of exclusion from, or reductions in the availability of, common property resources or land on which they once relied for self-provisioning of food.

Summary: This section presents quite mixed findings on the impacts of indirect consumption linkages in food security. 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 final 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 (e.g. Jahan et al. 2010). Increases in income may in turn translate into improvements in living standards, which may occur in the present or be transmitted intergenerationally. The case study excerpts presented below illustrate a variety of such effects.

- **Vietnam:** One hectare of rice-field in Bac Ninh province yields an average of 8-11 tonnes of paddy per year, worth VND 30-40 million. In contrast, each hectare under the VAC system of aquaculture is estimated to have an average yield of 7-10 tonnes with a net profit of approximately VND 80-120 million. Furthermore, farmers producing fish are also able to harvest significant quantities of vegetable, livestock and poultry from these integrated farming systems. Just one year after conversion of rice paddy to aquaculture, the average annual income from aquaculture of each local farmer is estimated at VND80 million for one ha of farming area.

- **Kenya:** There are some similarities with the example from Kenya where conversion of waterlogged infertile land with previously poor crop production to aquaculture facilitated dramatic increases in income. One farmer who have under taken such as conversion

reported that she had managed to educate three of her grandchildren using money obtained through aquaculture activities, and that using profits from her seven fish ponds, she had also been able to purchase other assets including cows and pigs, an electric generator, and household items, and to fulfill other household demands. Similar experiences were reported by many of the other the respondents interviewed for the case study.

- **India (Andhra Pradesh):** In Andhra Pradesh the decision to convert agricultural land to ponds also frequently reflected the comparatively limited returns available possible paddy cultivation and the potentially more lucrative nature of aquaculture. The decision to make this change was by no means risk free however. During the study several former paddy farmers were interviewed who had had lost money repeatedly after converting their smallholdings to aquaculture. These losses had resulted in them selling all or part of the land, or leasing it out neighboring farmers, and in some cases becoming laborers on their farms themselves. Conversely however, some farmers with starting from a low socioeconomic base had been highly successful, including one interviewee who had converted 4 ha of agricultural land to shrimp ponds and gradually expanded to operate a holding of 40 ha under a combination of fish and shrimp, in addition to which he had established an ice factory and feed dealership.

- **Philippines:** When market price of the seaweeds is favorable, seaweed farming is very attractive to seaweed farmers in the Philippines people, and the activity has significantly helped improve the economic status of adopting households since its introduction. The activity generates high returns, especially when family labor can sustain the business. As a result, seaweed farming families have been able to build decent homes, purchase electrical appliances, and expand seaweed production facilities such as drying platforms, warehouses, and farmhouses. In addition to providing income with which to purchase food and goods, seaweed farming has enabled some households to send their children to school, and it is common to hear of the daughters of a seaweed farmers becoming teachers in nearby elementary schools, suggesting the existence of lasting intergenerational impacts on poverty reduction.

- **China:** Members of an aquaculture cooperative in Wuhan, China were reported to have received many benefits. In 2012, the cooperative paid out CNY 31 250 in profits to each member farmer. In addition, the net profit of coop members was RMB 1 000 per mu than that of non-members. Several factors contribute to these higher earnings: Co-op member farmers received a bonus reduction of CNY 100 per ton of feed from the company supplying them, based on the bulk volume purchased. The marketing efforts of the cooperative also meant that the price received by member farmers for grass carp and silver carp was RMB 0.2/kg higher than the usual market rate, and the price of black carp was RMB 1.0/kg higher.

- **Brazil:** The monthly income of the "Association of Shrimp Farmers of Icapuí" (Associação dos Criadores de Camarão de Icapuí (ACCI)), is around R$ 1 000, with additional bonuses, depending on farm results. In contrast, the average monthly income the population from the villages, where most ACCI members reside, does not exceed the

national minimum wage (R$ 724.00/month). This indicates that family income from shrimp farming has raised the living standards of ACCI members in comparison to other residents, despite the former possessing lower levels of education. This improvement in incomes was reflected in increases in the percentage of members who owned bicycles, cars and mobile phones after the shrimp farm started to operate.

- **Nicaragua:** The average income received by members of three women managed shrimp farming cooperatives in Nicaragua was around USD450 per productive cycle. With an equivalent value of USD150 per month, this sum is below the legal minimal wage for formal employment of USD160. Although profits from shrimp farming were low, meaning that members often had to earn income from other sources, they were sufficient to allow women cooperative members to cover 35% of their monthly consumption expenditures, as well as increasing access to education and health care.

- **Bangladesh:** The average expenditure of 'aquaculture producer' households was between 5% and 24% higher than the all household average in all six villages. In villages where smallholders were not involved in commercial forms of aquaculture in large numbers, there was very little difference in the expenditures of 'no aquaculture' households and the all household average. In contrast, in the three villages with high concentrations of commercial smallholder aquaculture, there was a gap of 24-36% between the expenditures of these two groups. This seems to suggest that although producer households were only somewhat better-off than average in communities where a high proportion of households practiced commercial aquaculture, this was partly because participation in aquaculture had raised average incomes.

  The Bangladesh case study also explored the question of whether poor households are able to engage directly in commercial forms of aquaculture as producers. On average, in all villages surveyed, aquaculture producer households were less likely to be poor than those not practicing aquaculture. Never-the-less, a high percentage of poor households (37%-45%) participated in commercial aquaculture in all three villages with high concentrations of commercial smallholder aquaculture, and a significant proportion of aquaculture producers (8%-20%) lived in poverty. The largest differences in poverty levels between aquaculture producers and 'no aquaculture' households were found in villages where a large number of smallholders practiced commercial. This finding suggests that the level resources needed to enter commercial aquaculture limited direct participation by participation by the poor. However, it also seems to imply either that widespread participation in commercial smallholder aquaculture in these villages helped to reduce average poverty levels, or that those excluded from the activity were exposed to deepening poverty, or that both tendencies operated simultaneously. In two villages where there was little commercial aquaculture, poverty rates among 'no aquaculture' households were close to the all household average, suggesting that subsistence-oriented forms of the activity had a somewhat limited poverty reducing effect.

- **Ghana:** A contrasting situation is found in the Ashanti Region of Ghana, where only 50% of non-commercial pond aquaculture farmers surveyed were found to have positive net profits and be financially viable. Small-scale aquaculture had positive direct impacts

on the livelihoods of *non-poor* fish farming households who were trained and/or followed good management practises. These impacts depended largely on the household and livelihood characteristics and knowledge and management practises of these farmers (termed fish farming Type A). However, although poor households have been able to adopt small-scale pond aquaculture, the activity was found not to have strong positive direct impacts on poverty and livelihoods of these *poor* households (termed fish farming Type B).

Controlling for other factors, household participation in fish farming Type A is likely to increase household income by 54 percent, but participation in fish farming type B is unlikely to be associated with increased income when compared to non-fish farming households, suggesting that type A small-scale pond aquaculture has a positive effect on income, but not type B. Thus while small-scale fish farming type A is likely to have a positive impact on the income, and other related indicators, of non-poor farmers, small-scale aquaculture type B is unlikely to have much impact on poor farmers, unless their resource constraints can be overcome and they engage in type A. The other major type of aquaculture practiced in Ghana, commercial cage aquaculture on Lake Volta, is unlikely to have direct impacts on poverty via adoption by poor farmers, as the poor are unable to afford cage aquaculture due to high costs of investment and working capital.

Summary: Households which practice aquaculture are, on average, less likely to be poor than those that do not. This finding on its own reveals nothing about causality, however (i.e. the question of whether better-off than average households took up aquaculture, or whether households taking up aquaculture became better-off than average remains unanswered). However, the case studies reveal many examples in which the living standards of households adopting aquaculture have improved as a result.

Indirect income linkages

This section explores case study results illustrating two sets of indirect income linkages: employment generation, and economic multipliers, whereby 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.

Employment generation:

- **Chile:** Analysis of employment data for Chilean mussel farms located in the Lakes Region, showing that for 2008 indicates that small and medium farms (those of 10 hectares or less), accounted for 75% of total farms and, generated 63% of total permanent employment and 74% of total temporary employment. In the case of Gracilaria farming, small and medium farms accounted for 96% of operations in 2008, and generated 82% of total permanent employment and 87% of total temporary employment. This amounted to total employment for 2 987 permanent and 3 350 temporary workers in mussel farming, and 1 567 permanent and 1 092 temporary workers in Gracilaria farming. The minimum wage in 2007 was set at 276 USD/month. Farm operators and assistants received an average gross monthly income of USD224 per month which was only 81% of the official minimum salary. However, the gross monthly income for farm managers in mussel aquaculture was 2.5 times higher than the minimum wage. Divers also received USD539/month, which is 2 times the minimum salary and “Other” category workers, a

group which include temporary personnel, received 2.1 times the minimum wage, at USD577/month.

- **Nicaragua:** In 2009 the aquaculture sector in Nicaragua generated around 15 850 jobs, divided between farm operators (87%), administrative personal (10%) and technical personal (3%). Shrimp farming practiced by the three women's cooperatives which were the main focus of the case study generated direct employment for 26 women members. Employment of workers from outside the cooperatives' membership varied due to differences in size and farming technologies employed. On average they the co-ops generated 5-10 permanent jobs each, for activities such as maintenance of production ponds, feeding, and routine labour. Temporary jobs are created at harvest times (every three months), mostly in for selecting, de-heading and cleaning shrimp. It is estimated that between 10-20 peoples are hired for these harvest activities per co-op, of which around 80% of those hired for de-heading shrimp are women.

- **Philippines:** Seaweed farming in the Philippines employs several types of workers: Splitters, who split and tie seedlings to long lines are paid Philippine pesos (P) 5 per 50 meter long line. Planters are divers who fixe the long line with the seedlings to the sea bottom. They are paid P 250/day. During harvest time, the laborers employed for harvesting are receive P250/day. Harvested seaweeds are then sun-dried by driers, who are paid P200/day. The dried seaweeds are packed in sacks by laborers who are paid P10/sack, and loaded onto boats by porters for P10/sack, for transport to buyers who are mostly the processing plants and exporters. When not working in the family farm, some family members are also hired as workers in other nearby farms and this allows them to earn extra income. When production cycle is in full swing, the workers earn enough money to cover the daily needs of their families.

- **China:** In the case of the carp farming cooperative studied in China, the more advanced farming system deployed by cooperative members generated an increase in employment for temporary workers in jobs such as pond cleaning, harvesting, etc. The cooperative's formation also generated employment about 15 brokers in the village who traded fish produced by members. The technical consultation and support services provided by the cooperative also meant that family labour was released, allowing younger family members to seek urban employment opportunities, remunerated at CNY 30 000 per year on average.

- **Ghana:** The SME cage sector in Ghana creates much more direct and indirect employment than the small-scale pond aquaculture sector at present, measured in terms of total numbers of jobs. However, given equivalent increases in investment and scale, this would not necessarily be the case. It is estimated that (including pond construction) small-scale pond aquaculture generates 0.3 FTE on-farm jobs per USD1 000 invested and 0.03 FTE jobs per USD1 000 not including pond construction) while small-scale cage aquaculture generates approximately 0.1 FTE on-farm jobs per USD1 000 invested. The number of jobs created per USD1 000 investment by medium-scale cage aquaculture is likely to be lower than this. While these estimates are only an approximation, they provide an indication that if employment generated by pond construction is taken into

consideration, small-scale pond aquaculture could potentially create more employment per dollar invested than SME commercial cage aquaculture

- **Kenya:** Pond construction was also an extremely important source of employment related with aquaculture in Kenya. The FFEPP reportedly generated 10 short-term pond construction jobs for every direct job created for fish farmers. Many of these workers were reported to have gained useful knowledge and skills enabling them to earn a living as "pond engineers. There was also a reported employment ratio of 1:2.7 for other forms of indirect employment, primarily casual labour such as fish harvesting. Women are reported to perform most pond management activities for their own ponds, although men are the usually owners.

- **Vietnam:** The conversion of low-lying rice paddies into aquaculture in Bac Ninh has attracted a great number of local laborers. In 2001, before conversion to aquaculture took place, around 500 people worked as labor in fisheries sector. This number had increased about 16 times to about 8 100 by the year 2010. According to interviewees, each household has to hire from 3 to 5 workers per day during harvesting season and for pond construction. Larger farms also hire one fixed worker with an average monthly salary at VND2.5 – 3.0 million to manage ponds. The higher demand for labour and increased labour productivity associated with the shift from paddy cultivation to aquaculture has resulted in higher wages. Workers performing agricultural labour are paid an average of VND 80 000–100 000/day, whilst those involved in aquaculture are paid an average of VND150 000–180 000/day.

- **India (Andhra Pradesh):** An estimated 177 000 people derive their livelihoods from employment in freshwater aquaculture in AP, performing a highly diverse range of often specialized activities. As in Vietnam, on-farm employment in aquaculture generally appears to compare favorably to that in agriculture in terms of working conditions. compared to agriculture, and workers are opting for part-time labour which allows them to pursue other activities later in the day. Employment in day labour related to aquaculture is remunerated at around Rs.250-300 per day (USD4.40-5.30/day). This is similar to or slightly higher than the rate paid for agricultural day labour. However, whereas agricultural labour activities such as planting or harvesting rice typically last at least seven hours (e.g. from 6 am to 1 pm), and are characterized by a steady work rate, labour associated with aquaculture (e.g. harvesting fish ponds, packing fish for transport, or preparing ponds for stocking) is often associated with more intensive but shorter bursts of activity, with pond harvesting and preparation work typically lasting 4-5 hours from 6-11 am.

  Day laborers working in aquaculture often receive meals or fresh fish in addition to their daily wage, whereas agricultural laborers do not. Thus, day labour related to aquaculture is usually considered preferable to agricultural day labour. Marked intergenerational improvements in educational achievement were reported by laborers engaged in aquaculture. However, these have occurred over a time span when access to education in AP was improving more broadly, making it difficult to draw a causal link between these changes and the effects of aquaculture.

Although aquaculture has created many jobs with often somewhat better conditions than comparable employment in agriculture, interviewees generally considered demand for labour in agriculture to be higher than in aquaculture, particularly for women, so it is possible that freshwater aquaculture has resulted in a net reduction in total employment, especially on-farm. However, AP's economy has developed to such an extent that agriculture now competes with other sectors for labour, pushing up wages and creating shorter and more standardized working hours and labour shortages. In this context, the lower labour intensity of aquaculture as compared to crop farming helps to maintain the viability of the rural economy.

- **Bangladesh:** A similar trend was identified in Bangladesh, where an inverse relationship between the proportion of residents of each study village deriving employment from aquaculture and agriculture was observed, suggesting that the conversion of agricultural land to aquaculture displaced crop-farming as an occupation. However, commercial aquaculture tended to generate a higher average demand for hired labour per unit area than paddy cultivation, due in part to the longer duration of its cropping cycles. Wages for day labour in agriculture, aquaculture and the non-farm sectors were broadly comparable outside of periods of peak demand. Thus, although the expansion of commercial smallholder aquaculture occurred at the expense of employment in agriculture, the general tendency was for it to create more opportunities than it destroyed, to smooth seasonal demand for labor, and to do so on terms comparable or preferable to those in agriculture.

  In three villages with high concentrations of commercial smallholder aquaculture, aquaculture and related occupations combined contributed between one half and two thirds of total employment. Aquaculture producers were also the largest single occupational group in these villages, accounting for 23-35% of total employment. Aquaculture generated an employment multiplier of almost one in in two of these villages (i.e. every aquaculture producer created one additional related job within the village on average). In all four villages where commercial aquaculture was a significant activity, per unit area demand for hired labour in aquaculture was approximately two to three times greater than that in agriculture. In contrast, employment associated with semi-subsistence fish production in homestead ponds was very limited.

Summary: The case studies presented above indicate a variety of characteristics associated with employment related to aquaculture. Incomes gained from temporary and permanent employment on farm 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 different 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) which are favorable compared to 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 actually higher than demand for labour in aquaculture, although the reverse seems to be true in

Andhra Pradesh, India. The Ghana case 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.

Economic multipliers:

- **Ghana:** The only case study to address the nature of economic multipliers in detail was Ghana. Based on econometric analysis the study it concluded that, in Ghana, aquaculture has higher potential to impact on poverty through indirect economic multiplier effects, than directly through increasing the incomes and food security of poor fish farming households. Potential economic multiplier effects were estimated to be stronger for small-scale pond aquaculture practiced with adequate management and resources, (fish farming type A), than for SME cage aquaculture. Thus, for equivalent increases in scale, small-scale pond aquaculture (fish farming type A) was found to have more potential to generate broad-based, pro-poor economic growth than SME cage aquaculture. However, at present the actual and potential growth of the pond aquaculture sector is much lower than the cage sector, so the actual aggregate multiplier effects of the latter are almost certainly much greater

  Due to the low level of development of the pond aquaculture sector in Ghana at present and the small numbers of fish farms in dispersed villages, the impact of consumption linkages generated by pond aquaculture is not generally observed at the community level. However, Kassam (2013) estimated that for every extra dollar of income earned by 'Type A' fish farmers in the Ashanti region, 44% would be spent on regionally non-tradable goods and services and 62% will be spent on nationally non-tradable goods and services. If spending of extra income by fish farm employees is also considered, consumption linkages may be even stronger, as marginal budget shares for non-tradable goods are higher for poorer people as they tend to spend a higher share of their income on locally produced goods and services. This indicates that there is high potential for increasing local economic activity if the small-scale pond aquaculture sector were to develop.

  The potential regional and national multipliers from small-scale pond aquaculture (fish farming type A) are estimated to be between 1.6 and 1.8, and between 3.0 and 3.5 respectively. In contrast, the potential regional and national multipliers from SME cage aquaculture are estimated to be 1.1, and 1.5-1.6 respectively. An extra dollar of income from small-scale 'Type A' pond aquaculture in Ashanti Region is estimated to generate between USD0.6 and USD0.8 of further income within the region and between USD2.0 to USD2.5 of further income nationally. In comparison, an extra dollar of income from SME cage aquaculture in Eastern Region is estimated to generate just USD0.1 of further income within the region and between USD0.5 to USD0.6 of further income nationally.

Summary: As the Ghana case study indicates, economic multipliers associated with the goods and services procured using incomes derived from aquaculture by producers and workers (referred to by economists as 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.

Summary

Key findings from the case studies which relate to the contribution of aquaculture to poverty alleviation & food security are summarized in Table 2 below.

Country	Contribution of aquaculture to poverty alleviation & food security
Bangladesh	• Commercial aquaculture in which smallholders are engaged yields biggest impacts on employment, poverty, food security, but some negative or ambiguous effects
Brazil	• Alternative livelihoods for fishers; Improved farm performance raised producer incomes
Chile	• Modest impacts on food security and poverty
China	• Significantly improved farm profitability
Ghana	• Small-scale pond aqua by non-poor households has positive impact; Economic multipliers from successful pond aqua greater than from cage culture
India 1	• Increased productivity, income, fish consumption and employment
India 2	• Major impact on economic development • Impact on food security at national, but not necessarily at local level
Kenya	• Job creation (especially pond construction)
Nicaragua	• Job creation; Farm income improved
Philippines	• Broad-based improvements in living standards; Employment generation
Uganda	• Contributions to fish consumption and income
Vietnam	• Increased productivity, income and employment

Table 2: Summary of direct and indirect poverty and food and food security impacts, by case study

Enabling conditions, institutional arrangements and public-private partnerships contributing to aquaculture development

Examples of interventionist arrangements for development

The following subsection documents in detail four case studies of aquaculture development stimulated by 'interventionist' approaches. These include: a cross sectoral approach to stimulating the emergence of a commercial aquaculture sector led by the Kenyan government; enactment of a policy permitting the conversion of low yielding rice paddy to aquaculture ponds in Vietnam; an example of a successful Public-Private Partnership (PPP) in China, resulting from a policy decision to promote agricultural cooperatives, and; the creation of an enabling environment for aquaculture development in Chile through the provision of a legal framework to support aquaculture development in coastal areas and technical support for industrial development from state-run research institutions.

State-led aquaculture development programs

In the years 2009/2010 through to 2012/2013, the Kenyan government spearheaded the actualization of the Vision 2030 (Kenya's development blue print) through a flagship Fish Farming Enterprise Productivity Program. This resulted in a rapid increase in aquaculture production from around 4 tonnes in 2007 to 21 488 tonnes by 2012. The program covered high rainfall areas as well as arid and semi-arid lands and coastal areas where aquaculture had not previously developed and created awareness among small-scale farmers on the viability of farming fish as an alternative agricultural enterprise.

The main goal of the program was to produce food, create employment and generate income, particularly for the young unemployed Kenyan's and their associated households. The main activities included: pond construction and management, feed trials, brood stock management, seed production and evaluation of growth performance under different feeding regimes. The key conditions that made this success possible have mainly been put into place by the public sector. Most emphasis has been put on capacity building through trainings and demonstrations to farmers, market promotion through formation of clusters and "eat more fish" campaigns organized by the government in areas where fish consumption has not been well adopted. The government has also provided direct support to small scale fish feed/fingerling producers through provision of simple pelletizing machines and targeted capacity building.

Most of the trainings and demonstrations conducted by the government have been based on general pond management, post-harvest handling of fish, basic value addition and handling. This has led to a total consumer attitude change where it had initially been assumed that farmed fish had a flat taste. The value addition component has also empowered fish farmers on the proper ways of preparing and cooking fish – a skill which they transfer to consumers when marketing their products. Consumers have also been directly sensitized though the 'eat more fish' campaigns that have been organized by the State Department of Fisheries in public for a where members of the public are invited to participate and are trained on fish production and management, harvesting, marketing, preparation/cooking and tasting. Other strategies which have contributed to the success include construction of fish ponds in institutions of learning to promote aquaculture education at an earlier age and the extension of acquired knowledge to family ponds at home

Sector-specific enabling policies

The case of Bac Ninh province in northern Viet Nam provides an example of how targeted government policies specific to aquaculture can impact the activity's development. Due to their low-lying terrain, in many provinces in Vietnam, including Bac Ninh, some rice paddies can only produce one crop of rice per year due to low productivity or flooding. This often causes the farmers to abandon that farm land. Therefore, in 1999 the government made a decree 224-TTg, which allows farmers to convert inefficient low-lying rice paddies into aquaculture to alleviate poverty by increasing productivity.

The conversion of low-lying rice-fields into aquaculture has developed widely and speedily, especially after government policies on rural economic structural transformation were issued. Decision No. 224-TTg dated 08.12.1999, signed by the Prime Minister gave approval for an "Aquaculture Development Program for the period from 1999 to 2010". This created favorable conditions for aquaculture development throughout the country by allowing rice-farmers to convert low-lying fields, salt pans, waterlogged fields and unproductive rice-fields to aquaculture. As a result, the area of ponds constructed on low-lying lands increased rapidly, from 870 ha in 2001, to 3155 ha in 2013. Following the increase of pond area, the province has implemented aquaculture zoning projects. In the aquaculture zone, farmers have been actively intensified production methods. As a result, average farm productivity rose dramatically, from around 2.7 t/ha in 2001, to 6.15 t/ha in 2013.

Department of Agriculture and Rural Development (DARD) of Bac Ninh province has supported the successful implementation of this policy by the promotion of farm economic development through application of the VAC model of integrated aquaculture. In 2013, 639 households were provided with 13 million fish seeds, with a total value of VND 15 billion. Three private and public partner hatcheries were approved for supported for replacing the old broodstock, at a cost of VND 450 million. In addition, technical support was provided to the farmers through numerous aquaculture training courses, focusing on aquaculture techniques, health and disease management, and food security. Workshops and field trips were organized for farmers for the transfer of recently developed aquaculture methods.

The Fisheries Unit of DARD has coordinated closely with other private aquaculture suppliers and public organizations in the administration of technical support to aquaculture producer households and hatcheries. However, there is fewer aquaculture staff in charge at fisheries units of province and communes, so there is still some shortcoming when coordinating to implementing the state management task in some localities.

Successful Public-Private Partnerships

China provides a particularly compelling example of how public private partnerships, realized in this instance through well-organized cooperatives, incorporating a range of private and state actors into the value chain to improve coordination can successfully enhance the technical and economic performance of aquaculture.

Agro-cooperatives are encouraged by the Chinese government in order to improve the efficiency of aquaculture in rural areas and enhance the competitiveness of agri-business. Cooperatives are voluntary unions formed by farmers producing the same product to ensure cooperation, and organization of economic activities and carry out democratic management. In 2006, the national

government passed the law on farm cooperatives, following which large numbers of aquaculture cooperatives were formed.

The Ganlu Black Carp Cooperative was formed in Wuxi in 2007, as a farmer's professional cooperative economic organization, consisting of farmers, brokers, and aquaculture technicians. It is situated at the Fishery Eco-Park Area in Songzhi village, Ehu Town, Xishan District of Wuxi, Jiangsu province, in eastern China. The establishment of the cooperative involved 102 households belonging to farmers, brokers, and technicians. The cooperative was registered by the Wuxi Bureau of Industry and Commerce in the name of GANLU Black Carp Professional Cooperative.

By 2012, the cooperative had expanded to include 120 households, and employed around 300 associated laborers, with a male: female ratio of 1:1. All black carp produced from the cooperative was branded "Ganlu" Black carp. A company named Wuxi GANLU Aquaculture Ltd., established in 2002 with a registration fund of RMB 5 million, also joined the cooperative, to provide and equipment and capacity for black carp processing.

The cooperative was formed with the aim of sharing risks, providing services to members and making profits, and implements the "Four Unities, One Guarantee" policy in materials supply, marketing and technical supporting. This policy is characterized by an industrial operating model of "*Cooperative + Company + Production bases + Farmers"*. Details of the four unities and one guarantee are described in more detail below.

(1) **Unifying feed distribution and supply**. The cooperative is responsible for purchasing live feed (snails, clams), complementary feed (maize and wheat) and pelleted feed in batches, based on the orders of member farmers. The material is directly distributed to member farmers. By doing this, the cooperative is able to make perennial sales contracts with quality aquaculture feed supplies store and Wuxi Tongwei Feed Co. Ltd. at competitive prices.

(2) **Unifying the supply of chemicals and drugs**. The cooperative also made contracts with Fish Chemicals and Drugs Distribution store of Changshu Aquaculture Technical Extension Station to ensure that the chemicals and drugs are follow the quality standard of the green food production protocol.

(3) **Unifying technical support and guidance**. Aquaculture experts are invited as technical consultants for black carp farming. A technical service contract was also made between Xishan District Aquaculture Technical Extension Station, Agricultural Technical Service Center of Ehu Town, and the Freshwater Fisheries Research Center (FFRC), to provide technical training 3-4 times per year, regular technical consultation and timely support of market information for farmers. Technicians must be available to provide support whenever fish diseases occur. Farmers are requested to keep record of the farming activities, and provide information during the inspection and audit process.

(4) **Unifying the marketing of aquatic products**. Up to 2012, the cooperative made sales contracts with Wuxi Ganlu Aquaculture Co. Ltd., Wuxi Jinbaozai Food Co. Ltd., Wuxi Xintianlong Food Co. Ltd. The brand of "GANLU" Black Carp has become recognized nationally as environment friendly product. Twenty professional brokers support the marketing

of these products. Now aquatic products produced by the cooperative are sold year-round, amounting to annual sales of 1500 tonnes.

(5) **Guarantee of stable profits for members**. Based on the agreement, farmers made sales contracts between cooperative and its members, dictating that the cooperative should provide the lowest possible prices for purchased inputs, and a minimum fish sale price for coop members.

The cooperative also helps to promoting national healthy aquaculture standard practices. Among the 250 ha ponds operated by coop members, 70 ha are recognized as a provincial standardized black carp farming demonstration area. There is also one fish hospital, one technical training school for farmers, one retail shop, and one shop for aquaculture accessories on the site. Through the intervention of the cooperative for small scale farmers, and especially by the adoption of the Four Unities and One Guarantee, farmers or producers are able avoid risks from market fluctuation and losses from diseases outbreaks, and obtain additional benefits from the cooperative, such as bonuses, subsidies for pond upgrading, purchasing feeds, and exposure to new technologies.

Enabling governance environment

The case of the development of the coastal blue mussel aquaculture sectors in Chile illustrates role of good governance in providing an enabling environment for the development of aquaculture; both through initial investments in applied research through state research institutions and its subsequent transfer to the private sector, and through the development of a legal framework to support the establishment of aquaculture operations in the coastal zone.

The development of the Blue mussel aquaculture industry occurred in four phases as follows: Phase I: previous to the General Law of Fisheries and Aquaculture (GFAL) of 1991, the beginning and early growth stages of the activity evolved based on results from research conducted by the Institute of Fisheries Development and universities such as Universidad Austral de Chile (UACH) and Universidad de Concepción (UDEC) in Chiloe, especially in Putemun near Castro city and Yaldad near Quellon city, where they operated collectors for wild larvae and seed production which were sold to small entrepreneurs in Chiloe. This activity was conducted in concession areas granted by the maritime authority for a renewable period of 5 years. The greatest challenge in accessing the rights to exercise the activity was to obtain the regularization of the concession, although there was an option of early occupation. The application requirements were minimal and the areas requested were relatively small (less than 10 hectares).

Phase II (1991-1999): During this period there was no policy, nor regulation promoting the development of the small-scale aquaculture of Blue mussel. The GFAL regularized the aquaculture concession system with the inclusion of environmental variables in 1998.

Phase III (2000-2009): The National Aquaculture Policy (NAP) and the Environmental Regulation for Aquaculture (ERA) were enacted. The NAP stated sustainable development of aquaculture as being the main objective of management and included an “equal access to the activity” as a goal, which led to the acceleration of the processing of applications to concessions of Small-Scale Aquaculture (SSA), especially in southern Chile. The ERA regulation and the System for Environmental Impact Assessment (SEIA) recognized the existence of different scales of production and thus, lowered the demands placed on less intensive and smaller aquaculture sites and projects. In spite of the above this period witnessed a significant increase in

interest from large-scale industrial business in conducting Blue mussel aquaculture. Many salmon farm operators and other entrepreneurs began to request new large areas for concessions and to buy existing concession areas, including those originally operated as small-scale Blue mussel aquaculture. In addition, the creation of 'mussel clusters' was promoted during this period for the coordination of resources and capacities. Several studies conducted during this half of the decade identified, characterized and proposed policy components and actions for promoting the further development of Blue mussel SSA.

Phase IV (2010-2013): The recently modified GFAL (Law 20334, 2013) formally recognized SSA and its importance to the development of aquaculture in Chile. During this period, representatives from the mussel aquaculture industry obtained support to create an institution for research and development of mussel aquaculture, the Technological Institute for Mussel Aquaculture.

In addition, the private sector is organized in various local, regional and sector wide associations and organizations, such as the Asociacion Gremial de Mitilicultores de Chile (AMICHILE) [Mussel Guild Association of Chile], the Asociacion de Productores de Ostras y Ostiones de Chile AG.[Producers Association of Oysters and Scallops of Chile], Asociacion de la Industria del Salmon de Chile A.G. -SalmonChile- [Association of Chilean Salmon Industry AG], Asociacion de Productores de Salmon Coho y Trucha - Acotruch A.G. – [Association of Coho Salmon and Trout Producers]. Most of these associations are constituted in large proportion by large-scale or industrial producers, though medium to small scale producers may also have participation. Small producers also organize themselves in unions and cooperative of local and/or regional representation.

Examples of immanent drivers of development

This subsection presents examples of immanent drivers of development. These include examples of aquaculture development led by both export- and domestic-market opportunities (in Chile and Ghana respectively), and development facilitated by the unilateral actions of pioneering individuals/companies, again in Ghana.

Export market led development

Small-scale aquaculture in Chile is conducted along the whole length of the country. The species cultured are Calico scallop (Argopecten purpuratus), Blue mussel (Mytilus chilensis), Japanese oyster (Crassostrea gigas), Shoe mussel (Choromytilus chorus), Chilean Oyster (Ostrea chilensis), Cholga (Aulacomya ater), Rainbow trout (Oncorhyncus mykiss), Northern river prawn (Cryphiops caementarius) and Gracilaria algae or "Pelillo" (Gracilaria spp). The two most important of these species are: Blue mussel, and Gracilaria which, combined, represented approximately 24% of the national aquaculture production of Chile, between 2012 and 2013. During the same period these two species represented approximately a 10% and 6% of total aquaculture export volume and value, respectively. 83% of blue mussel production is destined for export, with only 17% consumed domestically.

All aquaculture production of Gracilaria is exported either as dry algae or as final product (i.e.; agar-agar or colagar). Main importers are Japan, USA and Rusia representing 42%, 22%and 16% of the export value of the product in 2011-2012. Other importers are Thailand, Mexico, Denmark, Italy and Brazil (Fundacion Chinquihue 2013). The export market of agar-agar and colagar is oligopsonistic with three main processor-exporters operating, and one of them

controlling 85% of the export value, which amounted to USD43.7 Million in 2011. The export market for dry Gracilaria is more competitive, with seven to twelve exporters operating between 2008 and 2011, and an annual export value of USD5.2 Million in 2011 (Fundacion Chinquihue 2013).

Forty processing plants operate totally or partially with Blue mussel, of which 30 of possess category A or B to export to the European Union. A total of 66 exporters send mussel products to 44 countries. Main markets for Blue mussel are France, Spain, Italy, Germany, USA and the United Kingdom. Frozen mussel represents 85% of the total production, canned mussel 12% and fresh-refrigerated products only 3%. Ninety three percent of the frozen production is exported and only 7% is marketed in Chile. Blue mussel provided a total of 2 987 and 3 350 temporary jobs in 2008, while Gracilaria farming provided 1,567 permanent and 1,092 temporary jobs. Thus these two export-dominated aqua-industries contributed to substantial employment generation within Chile, while 17% percent of the blue mussel crop was consumed domestically, thereby contributing to food security.

Domestic market led development

Development of domestic demand for aquaculture products is very often linked to two key factors; the first, income growth which raises demand for non-staple foods (this process is often closely linked to urbanization); the second, the decline of capture fisheries production, which makes it necessary to meet demand for fish through expanded aquaculture productions. This interplay of factors is illustrated by a case study of the domestic market led development of aquaculture in Ghana.

Domestic demand for higher value products such as vegetables and some animal products such as chicken and fish has been increasing due to rapidly growing urban markets in Ghana. Over the past decade the urban population has been growing at an average of 4 percent per year compared to overall annual population growth of approximately 2.5 percent. Ghana's strong economic performance since the mid-1990s has also had a significant impact on poverty and urban incomes. The trends of urbanisation, economic growth and poverty reduction have led to changing domestic food markets in Ghana, shown by the rapid development of supermarkets, targeting better-off consumers, along with more broad-based changes in food habits illustrated by the growth of the chicken meat market. Similarly, significant urban markets exist for aquaculture products in Ghana (a factor driving much of the private sector led aquaculture development in Sub Saharan Africa). The demand for fresh fish is especially high in the south, in Accra, along the coast and around Lake Volta and the demand for processed fish such as smoked catfish is higher in inland areas such as Ashanti Region. At the same time as fish demand is increasing marine and inland capture fisheries is following a decreasing trend, providing significant opportunities for aquaculture development.

Ghana's positive economic performance over recent years, supported by relative peace, political stability, macroeconomic reforms and public investments in infrastructure, have encouraged an influx of foreign direct investments (FDIs) of various forms. FDI jumped from approximately USD144 million in 2005 to nearly USD1.4 billion in 2007 and was over USD3.3 billion in 2012 making Ghana the 5th largest recipient of FDIs in Africa. This trend is also reflected in the level of foreign investment in the cage aquaculture sector in recent years. The majority of medium and large-scale cage farms are owned by foreign investors. The government has been actively building a policy and regulatory environment that is more conducive to enterprise development

and Ghana was ranked twice as a top 10 reformer globally by the World Bank's Doing Business report.

At the same time as fish demand is increasing marine and inland capture fisheries is following a decreasing trend, providing significant opportunities for aquaculture development. Domestic fish supply in Ghana comes from marine fisheries, inland fisheries (from lagoons, dams, rivers, Lake Volta etc.), aquaculture, and imports. Marine capture fisheries production has been following a decreasing trend (from approximately 490 000 tonnes in 1999 to just over 330 000 tonnes in 2011). However, overall fish production increased by 10 percent between 2009 and 2012 from approximately 415 000 metric tonnes in 2009 to over 455 000 tonnes in 2012. Of this increase, approximately 20 000 tonnes originated from aquaculture (mainly tilapia), 15 000 tonnes from inland fisheries and over 5 000 tonnes from marine fisheries. Tilapia are now sold in an increasingly diverse range of outlets and forms, including hotels restaurants, tilapia 'joints' and 'chop bars'. 'Chop bars' are more affordable places to eat than restaurants and tilapia 'joints' and serve a range of Ghanaian dishes. Most chop bars tend to serve boiled or steamed tilapia, unlike restaurants and tilapia 'joints' which serve grilled tilapia.

Pioneering actors

A key supply side driver of immanent aquaculture development is the innovative behavior of pioneering farmers, companies and entrepreneurs, which is often crucial in establishing the initial conditions under which aquaculture development is able to occur. Examples of the importance of these behaviors in facilitating the emergence of nascent commercial aquaculture is illustrated with reference to the Ghana case study.

Despite many years of support to the aquaculture sector by government and donors, the aquaculture sector in Ghana did not really take off until the entry of two pioneering firms, Tropo and Crystal Lake Farms. The success of Tropo in particular, is a key driving force in the cage aquaculture sector and the impact on the sector can be traced back to Tropo's entry into the pond aquaculture sector in 1999/2000. A brief history of Tropo and Crystal Lake is described below, followed by a discussion of their key impacts on driving the development of the sector.

Tropo Farms was established by Mark Amechi, a half German, half Nigerian expatriate with an MSc in Aquaculture from the Asian Institute of Technology (AIT) in Thailand. Mark came to Ghana in 1997 to set up a fish farm, attracted in part by Ghana's easier business environment than his original choice of Nigeria. Mark established a large pond aquaculture farm in Asutuare (Eastern Region) near Lake Volta and Tropo Farms became operational in 2000. Due to the lack of good quality fingerlings in Ghana at the time, Tropo imported GIFT broodstock from Thailand (from Nam Sai Farms) and started producing fingerlings. There was no commercial feed on the market so Tropo initially prepared feed from locally available materials such as soya, and later started to import commercial feed. Soon Tropo was producing 800g tilapia and selling regularly at the farm gate.

In 2000, the first cage farm, Crystal Lake, was established in Lake Volta by a Ghanaian, female, entrepreneur with support from DANIDA. After successfully piloting cage technology with WRI in Akosombo, Crystal Lake imported large round cages, and WRI supplied fingerlings for the first two cages. Like Tropo, Crystal Lake prepared its own feed until 2005 when Ranaan feed became available on the market.

In 2003 the EPA found out Tropo had been importing GIFT which was banned and required all GIFT fish (broodstock, fingerlings and fish) to be destroyed. Tropo then moved into cage aquaculture in Lake Volta, and started production in Sept 2006. Unlike Crystal Lake, Tropo used small 6 X 6 X 6m cages built with low cost materials available in Ghana. These were based on a design commonly found in Thailand, which was adopted as a result of Mark's familiarity with aquaculture there. Tropo used the pond farm at Asutuare as a hatchery, using 'Akosombo strain' broodstock from WRI to breed a new Tropo strain. Fingerlings were produced primarily for the cage farm and for a time excess fingerlings were sold to other farmers. Tropo also imported commercial floating feed from Brazil.

As discussed above, much of the rapid growth in aquaculture production since 2006 has come from Tropo. Tropo reported production figures of approximately 3 000 tonnes in 2010, 4 500 tonnes in 2011, 6 500 tonnes in 2012 (though the actual figures are likely to be higher) and in 2013 Tropo established a new offshore site with plans for 72 industrial size round cages imported from Turkey in order to produce over 20 000 tonnes per year. Tropo is also building a new hatchery to supply enough fingerlings for the offshore site. Currently Tropo is considering taking on a partner to help finance this large increase in production.

Crystal Lake was not as successful as Tropo and found fingerling production to be more profitable. Now Crystal Lake is the largest private hatchery in Ghana, estimated to be producing 15 million fingerlings per year. These two pioneer fish farms have played a key role in shaping the development of the sector through: opening up the market for fresh tilapia; introducing low cost, locally made cage technology; demonstrating the possibility of commercial aquaculture in Ghana thus encouraging new entrants; and easing input constraints to the sector. These have all played an important role in driving the growth of the sector.

Examples mixed immanent and interventionist development

The case study presented in this final subsection illustrates the importance of the context of immanent conditions into which development interventions are inserted in determining their success, with reference to state led attempts to develop aquaculture in Uganda, and the role of the private sector in mediating these.

The Uganda Fisheries Department of the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) with support from development partners and active participation of the private sector and non-governmental organizations has in the past 14 years initiated a number of activities to strengthen the aquaculture sector. These have contributed to marked growth in aquaculture production. One initiative implemented by government has been the establishment of regional fry production centers to improving farmer access to seed. Government institutions, including Makerere University, Fisheries Training Institute and Kajjansi Aquaculture Research and Development Center (KARDC) play a major role in aquaculture research and human capacity development. Government has also established a conducive policy and operational environment. Aquaculture is recognized as an important sector in the 2010/11-2014/15 National Development Plan.

With the identification of aquaculture as a national strategic area, the sector has attracted substantial development support which has catalyzed its growth. Development partners supported initiatives include the USAID funded FISH Project which run from 2005- 2008. This project supported farmer-to-farmer technology transfer and the establishment of aquaculture

demonstration centers, facilitating farmer access to extension support. The project also supported the strengthening of Walimi Fish Farmers' Cooperative Society (WAFICOS), the biggest fish farmer association in the country, with a current membership of about 5003. WAFICOS hires technical staff to provide farmers with technical support and information about inputs and markets. Livelihoods and Enterprises for Agricultural Development (LEAD) which was a successor to the FISH project was implemented from 2008-2013 supported private farmers to undertake fry production and improve fish production practices.

Preliminary assessment shows that access to markets, proximity to successful commercial aquaculture farms and to aquaculture research centers, presence of fish farmer associations and a culture of fish consumption are major determinants of successful aquaculture development in any given geographical area in Uganda. The private sector's contribution to aquaculture development has included supply of inputs, farm fish production and provision of technical services.

Ugachick Poultry Breeders Ltd, the main commercial supplier of fish feed is estimated to supply approximately 30% of current national demand. Ugachick Poultry Breeders Ltd, SON fish farms and a host of other private companies have also emerged as major suppliers of fry. This has reduced the over reliance on KARDC for seed and contributed to improvement in availability of seed to farmers. Through the government funded National Advisory Services (NAADS) program, the private sector is also involved in providing extension services for fish farmers.

In spite of the recent achievement, the aquaculture sector in Uganda is still faced with a number of constraints. According to WAFICOS, availability and cost of feed is still a major constraint. Feed alone is estimated to constitute approximately 60% of fish production costs, but feed quality remains questionable. To address this constraint, a significant proportion of farmers prepare their own feed using formulae provided to them by KARDC. An increase in number of feed manufacturers could help ensure more competitive prices and more reliable supply. Inconsistent fry quality, poor transport infrastructure, poor access to utilities and lack of distribution facilities such as refrigerated trucks and cold storage facilities have also been identified as key constraints.

The afore-listed constraints seem to have more adversely affected some regions than others, contributing to regional differences in aquaculture development. The Central and the near Eastern regions have had a higher private and public sector support, including access to technical services, fry and feed. These regions have, arguably because of these advantages, coupled with better access to markets and accommodating culture recorded more growth in aquaculture production.

Summary

The forms and/or pathways to interventionist and immanent aquaculture development documented above are each illustrated by a single case study, but case studies compiled by AFSPAN member countries provide a range of additional evidence of similar enabling sets of conditions playing important roles in supporting the development of aquaculture. These are summarized in Table 3 below. As these indicate, immanent and interventionist pathways to development are not mutually exclusive, but rather tend to prove mutually reinforcing, with interventions unlikely to prove successful if immanent conditions are not in place (e.g. sufficient

[3] http://www.thefishsite.com/articles/1103/fish-farmers-associations-in-uganda

demand for fish, input supplies and marketing networks), but possessing a greater likelihood of success where these exist. As the case of Ghana shows, in some cases it is possible for the private sector to at least some of overcome these challenges without state support, but again, the chances of success are much greater where the state fosters an enabling environment (e.g. through provision of crucial infrastructure such as roads, and sound macroeconomic policy which leads to conditions under which demand for fish can grow and entrepreneurs can respond effectively).

Country	Enabling conditions
Bangladesh	• Rising incomes; declining inland fisheries; Important role played by state/projects early on; profitability relative to agriculture
Brazil	• Collapse of marine fishery; Domestic markets; Cooperatives
Chile	• Export-led macroeconomic policy; Technological innovation by research institutions; supportive governance structures
China	• Policy intervention (law on agro-cooperatives)
Ghana	• Immanent development in response to opportunities; Rapid growth driven by pioneer operations
India 1	• State led-development intervention; Subsidies to producers
India 2	• Immanent develop in response to opportunities; Important role played by state early on; Highly dynamic private sector; Farmer innovation; profitability relative to agriculture
Kenya	• State led-development intervention; Integrated campaign; Cluster based approach
Nicaragua	• Relationship between cooperatives and corporations
Philippines	• Good governance environment; state technical R&D support in initial phase of development; export markets
Uganda	• State led-development intervention; enabling environment
Vietnam	• Policy intervention; profitability of aquaculture relative to agriculture

Conclusions: Toward a more comprehensive understanding of aquaculture development and its impacts on poverty and food security

This report is based on twelve case studies from eleven countries in Asia, Africa and Latin America, compiled in order to: (1) Assess financially viable entrepreneurial aquaculture activities including small-scale operations and their contribution to poverty alleviation and food security; (2) Identify enabling institutional conditions and arrangements for food security and poverty alleviation, and; (3) Identify successful public-private partnerships contributing to aquaculture development in developing countries.

The cases cover a range of diverse range of aquaculture systems with highly varied socio-technical characteristics. The range of systems selected for case studies is unusual in its scope, (in terms of the geographical location, species farmed, culture environments, farming technologies, scale, capital intensity, market orientation, institutional arrangements, and women's participation) and lends itself to a broad comparative analysis, capable of drawing out similarities in underlying processes operating at different a range of spatial locations and scales.

Two conceptual frameworks were adopted as a means of structuring analysis of these diverse systems. The first was a quadrant, which posited a series of potential direct and indirect linkages among aquaculture, poverty, and food security. Case study content analysis revealed a broad array of examples of each category of linkages, validating this conceptual frame. The second conceptual frame was a was a binary one, which distinguishes two modes of development - interventionist and immanent: the first an intentional process, driven primarily by the state and other developmental actors, the second a more 'organic' process arising in response to market signals and driven primarily by the efforts of private sector actors. Country case studies illustrated the existence of a range of development processes falling along this spectrum, including several in which strong complementarities exist between the two.

Direct and indirect poverty and food security linkages

Key findings emerging from the first of the sets of analysis described above are summarized as follows:

- **Direct consumption linkages:** Case studies from India, Kenya, Uganda, Ghana and Bangladesh all provided evidence to support the existence of elevated levels of fish consumption among fish producers, indicating a correlation between adoption of aquaculture and increased levels of home consumption of fish. However the example from Ghana cautions that direct food security impacts of production may not always be well defined, and in some cases may not occur at all.

- **Indirect consumption linkages:** Case studies from Kenya, India, Ghana and Bangladesh presented mixed findings with respect to the impacts of indirect aquaculture - fish consumption linkages on food security. Although the cases present strong evidence that increased aquaculture production resulted in increased availability of fish through the market and (in at least one case), reduced fish prices, it was not clear on the basis of the evidence presented whether this was in itself sufficient to guarantee that poor consumers' access to fish increased. In part this was because in the examples presented, production concentrated mainly on high value species, although it should be noted that in many countries, low and medium value fish species account for a large proportion of fish

produced. 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:** Case studies from Viet Nam, Kenya, India, Philippines, China, Brazil, Nicaragua, Bangladesh and Ghana indicated how increases in income derived from participation in aquaculture may translate into improvements in living standards, which may be transmitted either occur immediately or be transmitted intergenerationally. Although households which practiced aquaculture were less likely to be poor than those that did not, the qualitative nature of the case studies meant that it could not be determined with certainty whether this was because better-off than average households took up aquaculture, or whether households taking up aquaculture became better-off than average.

- **Indirect income linkages:** Case studies from Chile, Nicaragua, Philippines, China, Ghana, Kenya, Viet Nam, India and Bangladesh investigated two categories of indirect income linkage; employment generation, and economic multipliers. The levels of income gained from temporary and permanent employment on-farm and off-farm in the provision of services in related value chain activities span a wide range, as does employment intensity (the number of jobs created per area land or unit of capital investment). This reflects the range of local economic contexts in which aquaculture occurs and the labour intensity of different production technologies. One consistently observed pattern is that wages and terms of employment in aquaculture are generally favorable compared to those in other agricultural sectors. In some cases, demand for labour in aquaculture averaged over the course of a year was actually higher than demand for labour in agriculture. Important differences in employment intensity exist between commercial and small scale systems and production technologies. Small-scale pond aquaculture in Ghana performed better than commercial cage culture, with smallholder-dominated commercial aquaculture systems generating much higher levels of employment than semi-subsistence ones in Bangladesh.

- The Ghana study quantified the economic multipliers generated by the procurement of local goods and services using incomes derived from aquaculture by producers and workers. Referred to by economists as consumption linkages, these multipliers are extremely important in terms of their implications for economic development and poverty alleviation. The study found that commercial cage culture generated lower consumption linkages per unit of capital investment than small-scale pond aquaculture, although the former created higher levels of employment.

Development drivers

The second half of the report analyzed drivers of aquaculture development in terms of intentionally implemented, often state-led, efforts, and the ‘immanent’ outcomes of individual agency responding to a combination of favorable structural conditions and market demand. Case studies identified a variety of subcategories of both types of development. These are summarized as follows:

Interventionist development

State-led aquaculture development programs, represented here by the example of Kenya's successful cross-sectoral approach to stimulating aquaculture development through investments in pond construction, investments in technical capacity, concerted extension and outreach efforts, and social marketing activities to increase demand for fish.

Sector-specific enabling policies, such as Viet Nam's policy decision to allow conversion of unproductive low-lying paddy land to fish ponds, which resulted in rapid land use change and greatly enhanced economic returns to farmers in comparison to their previous agricultural activities

Successful Public-Private Partnerships, such as the impressive case of the Ganu Black Carp Cooperative from Wuxi, China, in which the formation of a highly successful collective enterprise based on mutually beneficial contractual arrangements between farmers, a major feed company, processors and distributors and government extension agents and services providers, led to impressive gains in productivity, profitability and the adoption of a sustainable long term business model.

The importance of an enabling governance environment in stimulating and supporting aquaculture industry growth is exemplified in the development of the blue mussel farming industry in Chile, with state funded research institutions developing and transferring technology which enabled the initial establishment of aquaculture for both species, and legal mechanisms later put in place ensure legal tenure and use rights to coastal lands, creating the conditions for an export-led industry to flourish.

Immanent Development

Export market led development, exemplified by Chile, where blue mussel and Gracilaria seaweed farming aimed primarily (mussel) and exclusively (Gracilaria) at export markets, created substantial income opportunities for small and medium producers, along with local employment

Domestic market led development, is probably the single most important factor in determining the growth of aquaculture worldwide. This tendency is illustrated by the development of cage based tilapia aquaculture in Ghana, which has occurred in response to declining per capita fish supplies, coupled to rising urban incomes fuelled by relative economic stability

The factors described above for Ghana with respect to the development of the domestic market, established the conditions under which the takeoff of aquaculture could occur. However, the innovations (both technical and institutional) which enabled this to take place, were provided by the agency of a small number of key pioneering actors, who assembled the production factors necessary to engage in aquaculture, who provided successful proof of concept of the production technology (thereby acting a demonstration for others to follow), and led the formation of markets for aquaculture products.

As the examples described above illustrate, immanent and interventionist development do not occur in isolation from one another. Rather, immanent conditions are a crucial determinant of the likely success of interventionist efforts. This is illustrated by a case study from Uganda, in which a state-led, nationwide effort to promote aquaculture development proved most successful in

those areas where private sector investment in aquaculture was already occurring, due to synergies between the two (e.g. supplies of feed and seed, and access to market channel), but far less effective in areas where immanent conditions were not conducive to take-off.

Recommendations for Best Practice

A number of key findings and best practice recommendations for stimulating aquaculture development which contributes to poverty reduction and food and nutrition security can be inferred from the evidence presented above. The case studies demonstrate that aquaculture has the capacity to contribute to poverty reduction and food security via a number of direct and indirect linkages. Aquaculture promoters should consider which effects they wish to induce when selecting interventions and which technologies and systems are most likely to meet these. These recommendations are summarized below

- With respect to food security, the largest gains occur at the meso and macro scales, where the expansion of aquaculture is sufficient to significantly increase fish supply, thereby reducing the price of fish relative to other commodities, bringing about increases in availability and accessibility. However, increases in fish supply do not automatically result in improved accessibility for poor consumers if the fish produced are high value species. Aquaculture developers should consider consumers as well as producers when making decisions regarding which species to promote.

- Numerous case studies demonstrate that adoption of aquaculture results in direct increases in fish consumption for producer households, resulting in greater food security. However, in many cases aquaculture producers are not among the poorest households in any given community, and aquaculture producers represent a small share of total population. Promotion of smallholder-inclusive commercial aquaculture which produces a substantial marketable surplus is therefore likely to bring about wider reaching gains in food security than promotion of subsistence or semi-subsistence forms of the activity which benefit a more limited numbers of adopting households.

- Direct participation in commercial forms of aquaculture by small and medium scale producers brings about clear benefits to these adopters in many instances, through income effects (since aquaculture usually generates far better returns than the production of agricultural staple crops). These may immediate, but may also have longer run intergenerational effects (for instance, by providing funds to educate children to so that they are able to pursue better paid non-farm jobs). Although resource constraints sometimes preclude direct participation by the poor in such forms of aquaculture as producers, the cases show that this is not always the case. Furthermore, commercial smallholder dominated forms of aquaculture also generate substantial employment, both direct on-farm and (more significantly) in provision in a range of related services up- and down-stream value chains. The conditions and remuneration of this employment are often favorable to those in alternative occupations such as agricultural labour.

- In contrast, while larger scale operations create some jobs, they tend to bring about less inclusive benefits, both because the number of producers directly involved is far lower, and also because the concentration in access to land required to facilitate large scale production excludes non-producers who may have obtained benefits from access to this

land prior to its conversion to aquaculture. Whilst small-scale subsistence or semi-subsistence aquaculture provides some direct benefits to producers, generally has low labour demands, requires few inputs, and generates limited surpluses. It thus creates few positive economic spillovers. In many cases, interventions which aim to stimulate the development of productive commercial aquaculture with high numbers of small and medium scale entrants are therefore likely to result in the most substantial and broadest array of benefits

- For interventions, the highest chances of success occur where favorable immanent conditions exist, or can be stimulated. Thus, there is little sense in promoting aquaculture in an area where there is no access to markets (for instance, in a remote area with very poor transport and communications infrastructure and a low population density), or a reliable supply of production inputs is not available. In these cases, interventions such as investments in road or construction or canal renovation, or the relaxation of import duties on feed materials, or the provision of specially tailored bank loans to prospective hatchery operators to are likely to deliver a higher chance of kindling success than, for instance, a program of pond construction and extension. In other words, interventions should focus on areas where the chances of success are highest, or work to change the structural conditions which hamper the possibility of achieving economic development in those which are not.

- Although attention often focusses on production for export, the expansion of domestic markets in line with economic growth and urbanization in Asia and, increasingly, Africa, is by far the most important driver of aquaculture development globally. The case study of shrimp production in Brazil, summarized in this report, shows that even aquaculture which developed to serve export markets may increasingly serve domestic demand as incomes rise. Policymakers should therefore avoid the tendency to favor export-oriented production over that which is responsive to domestic demand.

- Case studies presented in the report reveal cooperatives are highly variable in terms of their efficacy in enhancing productivity, profitability and market access for producers and providing opportunities for upgrading production. The most effective arrangements occurred where arrangements were mutually beneficial for producers and input suppliers, and where buyers, processors and distributors were integrated as cooperative members, facilitating “win win” scenarios. The effectiveness of cooperatives were also strengthened by close collaboration with government institutions for the provision of demand driven technical support, such as disease diagnosis and treatment, and the provision of assistance in attaining legal compliance with environmental legislation. Cooperatives functioned less successfully, and sometimes failed, where clear cut incentives such as these did not exist.

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Annex 1: Summary of country case study key findings

Country	Key finding	Theme
Vietnam	• The Decision No. 224-TTg dated 08.12.1999 created favorable conditions aquaculture development by allowing rice farmers to convert low-lying, waterlogged and low productivity fields • Between 2001 and 2013 the area under aquaculture in Bac Nihn province increased from 2538 ha to 5450 ha • One ha of rice-field yields an average of 8-11 tonnes/year, priced VND 30-40 million/ha/year; each ha of fish-farming yield an average of 7-10 tonnes with a net profit of approximately VND 80-120 million • Before the conversion, a working day was paid an average of VND 80 000 – 100 000, and after the conversion, a working day is paid an average of VND 150 000 – 180 000	• Policy intervention • Increased productivity, income and employment
India (Chhattisgarh and Jharkhand)	• The Government of India has introduced a scheme of reservoir stock enhancement and cage aquaculture, with fishing rights are leased to fisher's cooperative societies • In Chhattisgarh 7.8 million fingerlings were stocked in four reservoirs resulting in a 546 t increase fish harvest, worth Rs.54.6 million: an increase of 281%. Catches increased by 365% in Jharkhand. • Fishers, mainly members of tribal communities and backward castes, substantially increased their fish consumption and incomes • The scheme is heavily subsidized	• State led-development intervention • Increased productivity, income, fish consumption and employment
Philippines	• Seaweed farming generates employment of about 200 000 coastal families and in allied services • The average farm size is one ha. per farmer or per family. Majority of the seaweeds farmers are small-scale which is a family-based effort. • Seaweed farming employs several types of labor • Families have built decent homes, bought appliances, expand seaweeds facilities such as drying platform, warehouse, and farmhouse. Aside from providing resources for food and income, the farmers are able to send some of their children to school. It is common to hear stories of school teachers in nearby elementary schools being daughters of a seaweed farmer • The local government unit (LGU) of the area ensures the security of tenure/ownership of the tidal area intended for seaweed farming and is only awarded to bonafide residents of the Island. These farmers must have a community tax certificate. The local business permit to start a seaweed farm is affordable at P650, and there is a one-time payment of P250 as survey fee of the area. Municipal taxes of products are also implemented	• Small-scale commercial export-led aquaculture • 'Immanent development' • Broad-based improvements in living standards • Employment generation • Good governance environment

China	• In 2006, the national government approved the law on farm cooperatives • agro-cooperatives have raised the competitiveness of aquaculture businesses • Wuxi GANLU Black Carp Cooperative was established as farmer's professional cooperative economic organization in 2007 with 120 household members. • The cooperative provides the lowest price for purchased inputs and minimum fish sale prices for members • The coop has a contract for purchasing feed at competitive prices for distribution to member farmers. It also has a contract with private company for chemicals and drugs and a technical service contract with government for regular technical training, technical consultation, particularly when diseases occur. The farmers are requested to keep record of the farming activities, and provide information during inspection and audit process. The coop a sales contracts with a company which has branded GANLU" Black Carp and markets the product through 20 brokers. • In 2012 the coop increased about CNY 31250 to each member farmer. The net profit for membership farmers was RMB 1000 per mu higher than that of non-membership. Additional, member farmers received bonus provided by feed company, based on purchase amount of the year, with rate of CNY 100 per ton of feed	• Policy intervention • Improved farm profitability • Value chain coordination • Public private partnership
Kenya	• Kenya's aquaculture production increased from 4 250 tonnes in 2007 to 19 584 tonnes 2009 due to new government policies and increased funding • The Fish Farming Enterprise Productivity Programme • Nationwide approach: pond construction, capacity building through trainings and demonstrations to farmers, research, market promotion and provision of feed mixers and pelletizing machines to 54 farmers clusters, and "eat more fish" campaigns through media • Direct employment creation for over 52 000 fish farmers and indirect employment for many more • Media coverage and education played an important role in the program • Government's major role in aquaculture promotion resulted in impacts on a much larger scale than when a single organization is taking the initiative	• State led-development intervention • Integrated campaign • Cluster based approach • Job creation • Production increases

Uganda	• Improvement in aquaculture has been recorded in the central and part of the eastern region, less impact in North, West, and part of East. • Access to markets, proximity to successful commercial aquaculture farms and to aquaculture research centers, presence of fish farmer associations and a culture of fish consumption are major determinants of successful aquaculture development • Most aquaculture is small-scale, but some commercial production emerging • Aquaculture is an important source of fish for consumption by the producer households and most sales are to the surrounding communities • To hasten aquaculture development in Uganda, there is need to address the challenge of feed and seed.	• Slow development • Advances occurring where enabling environment exists • Contributions to consumption and income
Chile	• 1158 farms producing mussels and Gracilaria: • All Gracilaria and 83% mussels produced for export • the beginning and early growth stages of the activity evolved based on results from research activity conducted by the Institute of Fisheries Development and universities • State intervention required to define farming plots, and establish concessions to them • Policy framework favorable to small-scale operations (less stringent environmental regulations for smaller operations) • Fairly complete institutional setting and legal framework covering productive and environmental and sanitary aspects of the activity now exists and is enforced • Mussel production initially conducted by small and medium scale producers, but dominated by medium to large-scale producers since mid-2000s. Thus direct contribution to poverty alleviation is moderate. Gracilaria aquaculture conducted mainly by small-scale producers and makes a more directly contribution to poverty alleviation • Mussel aquaculture has moderate direct effect on domestic food and nutrition security. Gracilaria does not contribute directly, but may make indirect contribution through income and salaries.	• Export-led development • Technological innovation by research institutions • Supportive policy environment and good governance • Modest impacts on food security and poverty

Brazil	• Marine shrimp aquaculture in Brazil has grown rapidly to nearly 70 000 tonnes in 2011 • Of 1 222 farmers involved in this activity, 74% are small farmers (<than 10 ha) • Majority of small-scale farms do not have an environmental license and thus lack access to credit and technical skills • Two co-operatives studied: The main driver to start shrimp farming in both was the collapse of the lobster fishery • Incomes and standards of living of coop members improved since joining • One of the coops gained environmental permit after adopting BMPs and mangrove restoration with university support, allowing it to gain access to bank credit at favorable rates • Inputs are acquired through the association at lower prices than would be available for individual farms • The coops have confronted a number of severe challenges over the years	• Aquaculture stimulated by collapse of marine fishery • High value commodity contributing to poverty reduction • Coops improved economic and environmental performance • Coops not panacea for all problems
Nicaragua	• Most shrimp farming large scale industrial • There are 62 shrimp farms under semi intensive production system belonging to cooperatives. Cooperative members mainly have low incomes and levels of education • The women's shrimp culture cooperative generates income directly for 26 women members. 5 to 10 additional permanent jobs are generated per cooperative, and 10-20 people are hired for harvesting of which, 80% are women • The average income for shrimp cooperative members is USD 450 per production cycle (below the legal minimum wage of USD160/month) • Since 2009, cooperatives have cooperated with private corporations to gain working capital and provide technical assistance and assurance of quality standards. Production has increased a result • The coops have empowered women by allowing them entry into what was a traditionally male dominated activity • Not all the coops have been equally successful • Sector originally primarily co-op dominated. Corporations provided training & credit, but not equal distribution of risk/benefits? This model not successful. Corporations want coops so to reduce their capital investment/risk. More successful since 2009 as more equitable arrangements	• Empowerment of women coop members • Technical skills, production efficiency & income improved through coop links to corporations • Job creation • Coops not panacea for all problems

(India) Andhra Pradesh	• Estimated farm-gate value of freshwater aquaculture in AP was USD1.73 billion in 2012 • Most of the fish produced is marketed through Kolkata to other states, particularly Northeast • Carp production is largely semi-intensive, but a series of endogenous innovations (e.g. stocking large fingerlings, deeper ponds) have continuously raised yields • Wide range of farm sizes & types of farmer, but investment costs per unit area high • Technical support from state important for initial development, less so subsequently • Aquaculture in AP is highly dynamic and evolving extremely rapidly, reflecting: entrepreneurial culture; highly profitable nature of aquaculture compared other agriculture; access to markets; highly developed clusters of specialized service providers • 177,000 people derive their livelihoods directly from freshwater aquaculture • AP makes a major contribution to national fish supplies and has likely significantly reduced real freshwater fish prices, but nature of specific impacts on food and nutrition security unclear	• Immanent develop in response to opportunities • Important role played by state early on • Highly dynamic private sector • Farmer innovation • Major impact on economic development • Impact on food security at national, but not necessarily local level
Ghana	• Aquaculture production increased from 950 tonnes in 2004 to over 27 000 tonnes in 2012, of which 24,000t from cages • Growth in aquaculture production is related to increased availability of fingerlings and feed- the number of private hatcheries has increased and a feed mill was established in 2011 • Small-scale pond aquaculture does not have strong positive direct impacts on poverty and livelihoods of *poor* households • small-scale aquaculture has positive direct impacts on the livelihoods of *non-poor* fish farming households who are trained and/or follow good management practices • The potential economic multiplier effects and associated linkages (backward, forward, and consumption) are estimated to be stronger for small-scale pond aquaculture than for SME cage aquaculture • Factors important in driving the development of the sector are put into two categories: enabling conditions (increasing urban demand for fish, macroeconomic policy reforms encouraging economic growth and foreign direct investment, government support of the aquaculture sector); and events and actors (establishment of pioneer farms such as Tropo and Crystal Lake and the introduction of low cost cage technology). • Large pioneer farms were able to overcome constraints to the sector (access to input and output markets, appropriate technology etc.) through vertical integration of input supply, production and marketing activities. Their success encouraged new SME cage farmers, feed and fingerling suppliers to make simultaneous and complementary investments	• Immanent development in response to opportunities • Rapid growth driven by pioneer operations • Small-scale pond aqua by poor households has no direct impact on poverty • Small-scale pond aqua by non-poor households has positive impact • Economic multipliers from successful pond aqua greater than from cage culture

Bangladesh	• The wealthier a household, the higher the likelihood of its members practicing aquaculture as producers • participation of poor households with limited landholdings in some forms of commercial aquaculture was much higher than anticipated (in certain villages, more small landowners and the poor practiced commercial aquaculture than semi-subsistence forms of the activity) • The rise of commercial aquaculture was accompanied by a decline in the availability of land for paddy cultivation, sharecropping arrangements were replaced by dynamic rental markets which often facilitated small and medium producer access to land • There is an inverse relationship between employment in aquaculture and agriculture • *With the exception of shrimp farming*, smallholder dominated commercial aquaculture created more employment opportunities than it destroyed by smoothing seasonal demand for labor • non-commercial aquaculture created very limited employment opportunities • commercially oriented smallholder aquaculture producers consumed larger quantities of fish from their own farms than households operating subsistence oriented fish production systems • On average, individuals from households practicing aquaculture consumed (and produced) more rice, fruits, non-leafy vegetables and fish per capita than those that did not • The development of smallholder dominated forms of commercial aquaculture was accompanied by increasing levels of women's engagement in related work • the emergence of commercial forms caused producers to more deeply integrated into markets, and more dependent upon them for their means of their survival – some became more vulnerable and dependent on selling labor as a result • levels of material wellbeing often increased markedly for poor households able to enter commercial aquaculture as producers	• Commercial aqua in which smallholders are engaged yields biggest impacts on employment, poverty, food security, but some negative or ambiguous effects also

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SEVENTH FRAMEWORK PROGRAMME