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A COMPARATIVE ASSESSMENT OF THE POVERTY IMPACTS OF POND AND CAGE AQUACULTURE IN GHANA

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Abstract

Aquaculture is being promoted for poverty reduction in Low Income Countries. Theoretically, aquaculture can impact poverty directly by increasing income and food security of poor fish farming households, and indirectly by generating food and economic growth. However, there is limited empirical evidence of aquaculture significantly impacting poverty, especially in sub-Saharan Africa. The emerging paradigm in aquaculture development argues that indirect poverty impacts from commercial small and medium enterprises (SMEs) are greater than direct poverty impacts on small-scale producers. This paper assesses the potential poverty impacts of small-scale pond aquaculture and SME cage aquaculture in Ghana, comparing the relative significance of their direct and indirect impacts. Non-poor small-scale pond fish farmers who have been trained and/or use better management practices (BMPs) (termed fish farming type A) are found to hold the most potential to impact poverty indirectly through generating economic growth. These indirect impacts are higher than the direct impacts on poor small-scale fish farmers and the indirect impacts from SMEs. The findings support the current move away from a narrow focus on poor producers. However, it is unclear whether the arguments for expanding support to include SMEs are fully supported due to the ambiguity of standard fish farmer categories. If type A fish farmers are categorised as 'commercial micro enterprises' the findings support the paradigm shift. However, it is more likely that these farmers lie between 'non commercial' and 'commercial' categories. A more nuanced approach to aquaculture development, accounting for the wide spectrum of farmers whose characteristics differ between contexts, is required.

Keywords: Fish farming; income; small-scale, small and medium enterprise; sub-Saharan Africa.

Highlights

Small-scale pond aquaculture has limited direct poverty impacts on poor fish farmers in Ghana

Small-scale pond farmers who do not use BMPs have similar income levels to non-fish farmers

Small-scale pond farmers who use BMPs have significantly higher income than non-fish farmers

Small-scale pond aquaculture has potentially higher multiplier effects than SME cage culture

Small-scale pond aquaculture by non-poor farmers has higher poverty impact potential than SME cage culture in Ghana

1. Introduction

Governments and donors are promoting aquaculture development for poverty reduction and rural development in Low Income Countries (LICs). Theoretically, small-scale artisanal aquaculture can directly impact poverty by increasing household income and food security, lowering risk and improving resilience. Small-, medium- and large-scale commercial aquaculture can indirectly impact poverty by generating food, employment and revenues in local and export markets. However, there is limited empirical evidence of aquaculture significantly impacting poverty directly or indirectly (Charles *et al*., 1997; Stevenson & Irz, 2009; Arthur *et al*., 2013; Toufique & Belton, 2014), especially in sub-Saharan Africa (SSA).

Some experts argue that the development of commercial small and medium enterprises (SMEs) would have greater benefits for more people, through stimulating economic growth and reducing fish prices, than development projects focused on poverty alleviation of small-scale producers (Moehl *et al*., 2005; Brummett *et al*., 2008 & 2011; Little *et al*., 2012). Beveridge *et al*. (2010) argue SMEs are more likely to have the assets needed to grow and adopt more productive technologies resulting in increased production and on-farm and value chain employment. However, the poverty impact of different aquaculture systems has not been rigorously analysed and it is unclear whether direct or indirect impacts are more significant.

The aquaculture system(s) promoted for poverty alleviation in different contexts should be informed by an assessment of the poverty impacts of each system. Ghana's rapidly growing aquaculture sector, unusual among SSA countries, shows significant growth potential making it an interesting and relevant case study for other countries in SSA promoting aquaculture. Ghana's aquaculture sector comprises two main systems: ponds and cages. The vast majority of the pond aquaculture sector is made up of small-scale farms mainly producing tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*) in semi-intensive polyculture systems. The cage culture sector is comprised of commercial SME and large-scale cage farms producing tilapia intensively. Ghana's aquaculture sector has been studied in depth by Kassam (2013) who provides a comprehensive assessment of the direct and indirect impacts of the development of both pond and cage aquaculture systems on poverty and economic growth. Building on this work, the objectives of this paper are to compare the actual and potential, direct and indirect impacts of small-scale pond and SME cage aquaculture development on poverty in Ghana and contribute to the debate surrounding the emerging paradigm in aquaculture development discussed above (Brummett *et al*., 2008; Stevenson and Irz, 2009; Beveridge *et al*., 2010). The paper also seeks to contribute to the literature on agricultural growth linkages by estimating multiplier effects from aquaculture which has not been done before.

2. Aquaculture and poverty linkages

2.1. Conceptual relationship between aquaculture and poverty

Aquaculture's theoretical potential to impact poverty directly and indirectly has been clearly outlined in the literature (Edwards, 2000; Stevenson & Irz, 2009). Direct impacts affect households who adopt aquaculture *e.g.* through increased income and/or fish consumption. The poverty impact of these benefits depends on whether the poor adopt aquaculture. Indirect impacts result from aquaculture adoption by both poor and non-poor farmers *e.g.* through increasing fish supplies, potentially increasing the availability and lowering the price of fish (see Toufique & Belton, 2014). This may benefit poor domestic consumers (if production is not exported and the poor consume cultured species) and poor consumers elsewhere, however price reductions may not help poor producers. Aquaculture development can also increase on-farm employment of the poor and increase the marginal productivity of labour leading to higher rural wages.

Other potential indirect impacts include employment, wage and income effects on other sectors through production and consumption linkages (Haggblade *et al*., 1991). Production linkages include backward linkages from demanding inputs and services for aquaculture production, and forward linkages from demanding processing, marketing, storage and transport of production. Consumption linkages arise when increased farm income is spent on locally produced goods and services, often in the rural non-farm economy (RNFE). These linkages enable increased aquaculture production to stimulate growth in other sectors, producing an economic multiplier effect which could positively impact a range of poor people including landless farm workers, net labour-selling smallholders and the rural non-agricultural and urban poor. Table 1 summarises these impact pathways.

The extent to which aquaculture will contribute to rural development and poverty reduction is likely to be context specific and dependent on numerous factors including the: level of on- and off-farm engagement by the poor; scale of adoption; relative importance of direct income and production effects compared to indirect consumption effects benefiting poor consumers; and scale of indirect effects such as multiplier effects of different aquaculture systems.

Table 1: Summary of potential impacts of aquaculture

Potential impact	Pathway
Direct impacts affecting adopters	
Income	Increased on-farm income from own enterprise production
Consumption	Enhanced food and nutrition security from increased household fish consumption and/or as a result of higher incomes from sale of fish
Farm sustainability	Increased farm sustainability through adoption of Integrated Aquaculture Agriculture enabling more effective and efficient use of on-farm inputs (Edwards, 2000)
Indirect impacts affecting non adopters	
Consumption	Increased availability of fish for consumers
	Lower prices of fish which could increase access to fish for consumers while also negatively affecting fishermen
Employment	Increased employment on fish farms (potentially also boosting rural wages)
Economic growth/multiplier	Increased employment, wage and income effects in the aquaculture value chain through production linkages Increased employment, wage and income effects in other sectors through consumption linkages increasing the demand for locally produced goods and services creating an economic multiplier effect and boosting local economic growth
Environmental	Privatisation of common access grounds, degradation of capture fisheries habitats etc.

2.2. Empirical evidence

Few studies have systematically analysed aquaculture's direct contribution to poverty and empirical evidence concerning aquaculture's indirect poverty effects is mixed and incomplete (Arthur *et al*., 2013). Aquaculture promotion for poverty alleviation is generally viewed to have been unsuccessful in SSA (Harrison *et al*., 1994; Edwards & Demaine, 1997; Brummett *et al*., 2008). In Asia, although small-scale aquaculture has grown significantly, in general better resourced households have benefited rather than the poor (Halwart *et al*., 2002; Arthur *et al*., 2013).

2.2.1. Direct impacts

Development interventions in SSA have promoted 'small-scale' aquaculture, focusing on maximising direct income and consumption effects on poverty reduction (Moehl *et al*., 2005; Brummet *et al*., 2008). There have been very few *ex-post* impact assessments. Some studies have found aquaculture to have a positive effect on household income (Dey *et al*., 2007 in Malawi; and Brummett *et al*., 2011 in Cameroon). Evidence on direct consumption effects in SSA is limited.

2.2.2. Indirect impacts

Few empirical studies have assessed the indirect consumption effects of aquaculture on poverty. Some studies have measured price and income elasticities of fish demand in Asia (Dey, 2000a; Dey 2000b; Garcia *et al*., 2005). However, there is little empirical evidence, other than from Toufique & Belton (2014) in Bangladesh, that aquaculture reduces fish prices and benefits poor consumers.

Evidence of aquaculture creating direct employment for the poor and increasing rural wages is mixed and limited. Studies from Asia show low labour use in small-scale aquaculture (Ahmed & Lorica, 2002; Ahmed *et al*., 1993). Large-scale farms in SSA are not highly labour intensive (Brummett *et al*., 2008). Stevenson (2006) in the Philippines and Belton *et al*. (2012) in Bangladesh show that labour intensity varies across farm types. Some evidence suggests factor productivity is higher for aquaculture than agriculture resulting in higher wages (Dey *et al*., 2007; and Singh, 1999). Empirical evidence on indirect employment through the aquaculture value chain is also limited and mixed (Stanley, 2003; Costa & Sampaio, 2004; Stevenson, 2006; Belton *et al*., 2012).

Economic growth linkages have not been estimated for the aquaculture sector in LICs. However, there is a large theoretical and empirical literature on the effects of agricultural growth on the RNFE and most studies have estimated large agricultural multipliers in SSA (Delgado *et al*., 1998; Irz *et al*., 2001, Haggblade *et al*., 2007b). Delgado *et al*. (1998) estimated average agricultural multipliers in SSA to be over 2 (*i.e.* $1 of growth in agricultural incomes from tradables – goods and services which are imported or exported to/from the area - leads to an additional $1 or more of income from production in nontradables – goods and services which are produced and consumed locally and not imported or exported to/from the area). Haggblade *et al*. (2007a) found agricultural multipliers in SSA range from 1.3 to 1.5. The majority of studies estimate consumption linkages account for 80 percent of agricultural multipliers while production linkages account for the rest (Haggblade *et al*., 2007b). Growth linkages are likely to be most beneficial for the poor when direct effects of increased production are equitably distributed, as poor consumers tend to demand more local and labour-intensive goods than richer consumers (Hazell & Haggblade, 1993).

2.3. Comparison of direct and indirect poverty impacts

The relative importance of direct and indirect poverty impact pathways from aquaculture have not been assessed. There has been a debate in the agriculture literature about the relative importance of direct and indirect effects of technology changes on poverty with implications for the target groups of research and policies. For example Alston *et al*. (1995) argue technology's main benefit is increasing food supply and lowering prices. They suggest research should focus on maximising output through targeting larger farmers in more productive areas, leaving the poverty reduction of smallholders to other interventions. Others like Fan and Hazell (2002) argue that direct effects are the most important for poverty alleviation and attention should focus on resource poor farmers in marginal areas where research has been minimal. Empirical evidence regarding which farmer groups offer the strongest growth linkages is mixed. For example Mellor and Lele (1972) found higher-income rural people generated the largest consumption linkages in India; Hazell and Roell (1983) found medium-sized farmers in Malaysia and Nigeria generated the largest consumption linkages; and in a review of the literature, Tomich et al. (1995) suggest small farmers generate the strongest consumption linkages.

The extent to which aquaculture growth will stimulate growth in other sectors depends on a variety of structural features. Haggblade et al., (2007a) suggest a range of 'conditioners' that strengthen linkages including: entrepreneurial and technical skills to enable a supply response from the RNFE to meet increased local demand; good rural infrastructure to improve the responsiveness of the RNFE to increased demand; increasing population density enabling minimum efficient scales of production to be reached more easily; and a high marginal propensity to purchase non foods. Targeting interventions and policies to different farmer categories has important implications for the size and nature of spinoffs arising from aquaculture growth.

2.4. The emerging paradigm in aquaculture development

As noted above, several authors have highlighted the failure of aid to develop SSA's aquaculture sector and suggest a stronger focus on SMEs is needed. Moehl *et al*. (2006) argue that SMEs are the most effective economic growth engines with the highest potential to maximise aquaculture's poverty impacts in SSA, implying indirect impacts are more important than direct impacts. Brummett *et al*. (2008) note that although small-scale semi-intensive systems can create important benefits for poor producers such as increased food security, unlike SMEs, artisanal farmers create little or no economic growth as they generate minimal cash revenues and accumulate little capital for reinvestment and expansion. They also suggest large-scale systems have relatively less economic impact and tend to concentrate wealth more than would a larger number of smaller-scale investments. Along with others (Beveridge *et al*., 2010; Little *et al*., 2012) they argue for increased support to SMEs to make the most of the secondary economic opportunities created through the aquaculture value chain and maximise growth linkages and employment opportunities for the poor.

3. Aquaculture in Ghana

Aquaculture in Ghana began in the north in 1953 and is currently practiced in all 10 regions (Figure 1). Tilapia species represent over 90 percent of farmed fish production, with catfish and other species making up the remainder. Pond aquaculture is the dominant production system, accounting for over 98 percent of farms. The Ministry of Fisheries and Aquaculture Development (MOFAD) estimates there are over 4,700 ponds with an average area of 0.15 ha each (MOFAD, 2013). However, this figure is likely to be an underestimate with pond farmer estimates ranging from nearly 3,000 (MoFA/FC, 2012) to 4-6,000 (Frimpong and Fynn, 2014). The majority of pond farms are small-scale and produce less than 1t/year and between 1.5-2.5t/ha/year (*ibid.*). Pond farms are concentrated in Ashanti, Brong Ahafo, Central and Western regions with over 1,000 in Ashanti Region (MOFAD, 2013). Pond farms in Ghana are commonly classified as 'non commercial' following Moehl *et al.* (2006) who characterise 'non commercial' fish farmers as farmers with ponds who view aquaculture as one component of a diversified system and who do not run their aquaculture operations as a business.

In the last decade the dominant tilapia culture system has changed and the majority of farmed tilapia is now produced intensively in cages in Lake Volta. The first cage farm was established in Ghana in 2001 and there are currently 70-100 cage farms (Frimpong and Fynn, 2014) of which 3-5 are large-scale (producing over 1000t/year). The vast majority of cage farms are SMEs producing between 1-50t/year (small-scale) and 50-1,000t/year (medium-scale) located in Eastern and Volta regions, concentrated around the lower part of Lake Volta and the Volta river. Cage farms in Ghana are commonly classified as 'commercial' following Moehl *et al.* (2006) who define 'commercial' farmers as those who are primarily fish farmers of any scale who manage their fish farms as businesses with profit being the primary goal.

Official estimates indicate aquaculture production is over 32,000t (MOFAD, 2013), representing 7 percent of Ghana's total fisheries production. This figure is likely to be overestimated and industry observers interviewed estimated production was closer to 20,000t in 2013. Cage culture is estimated to account for nearly 90 percent of aquaculture production, ponds are estimated to contribute 8 percent with the remainder from dugouts, reservoirs and dams (*ibid.*). Due to the calculation methods official statistics are likely to overestimate cage farm production and underestimate pond farm production. Overall however cage culture produces the majority of farmed fish in Ghana with the largest five cage farms estimated to contribute 30-50 percent of total production.

4. Data and methodology

Data were collected from fish farmers and communities in Ashanti and Eastern regions where pond and cage aquaculture systems have developed respectively (Figure 1).

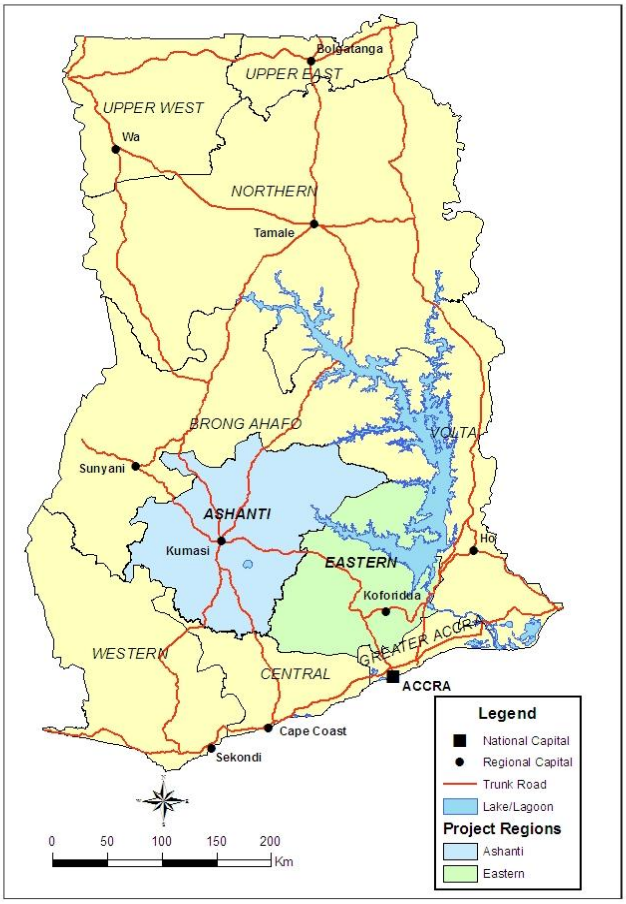

Figure 1: Study regions

Data and methods for assessing direct poverty impacts of aquaculture

A household survey was conducted in early 2011 to compare livelihood and poverty impact indicators (income, household wealth and food security) of 69 small-scale pond fish farmers and a comparison group of 74 non-fish farmers in three districts in Ashanti Region[2]. A sampling frame of 90 small-scale pond farmers who had stocked or harvested in the previous two years was constructed and as many of these farmers as possible were surveyed. The comparison group representing the counterfactual scenario was constructed using informal matching criteria as follows: each comparison non-fish farmer was: i) the nearest neighbour of the surveyed fish farmer; ii) within 5 years of age of the fish farmer; and iii) a crop farmer. These criteria were chosen as it was thought that farming households located close to each other with similarly aged household heads were likely to have similar household characteristics. Participatory wealth rankings (Grandin, 1988) were undertaken in three communities in Ashanti Region covering a total of 257 households to understand local perspectives on poverty and wealth, and determine if aquaculture was adopted by those the community considered poor.

Surveyed households are classified as 'poor' if their 2010 per capita income was under the US$1.25/day international poverty line at 2005 Purchasing Power Parity (PPP) adjusted for Ghana's 2010 PPP rate (GH¢ 390.55). Composite indexes are used to compare multiple variables between fish and non-fish farming households. A household asset index, representing household wealth, is estimated by assigning weights to the durable goods, facilities and livestock holdings owned by each

[2] Amansie West, Amansie Central and Adansi North districts.

household and summing over all assets (BMGF, 2010). The Food Consumption Score (FCS) is used as a food security indicator based on: dietary diversity, food frequency and the relative nutritional importance of different food groups (WFP, 2009). Chi square tests for independence are used to test the significance of differences between categorical variables and independent samples t-tests are used to test the significance of differences between the means of continuous variables.

Comparing impact indicators between fish and non-fish farming households may provide some indication of potential impact. However, unless households have been randomly placed into these groups using an experimental design or formally matched, these comparisons may not account for other possible differences in household characteristics causing differences in income and wealth between the groups. An Income Determination Model (IDM) is used to control for differences in observable characteristics between households and assess the factors that contribute to differences in per capita income between fish and non-fish farming households. The multiple log-linear regression model is estimated using Ordinary Least Squares. A two stage least squares model with instrumental variables is used to test for endogeniety bias (Heckman, 1997). A simple test of the null hypothesis of no sample selection bias using a consistent two-step estimator following Heckman (1979) is used to test for selection bias

The IDM assesses factors related to income within the population of fish farmers, in particular the association between training and better management practices (BMPs), and income. The household income equation can be written as:

$$\ln (y) = \beta 0 + \beta i.Fi + \beta j.Xj + \beta z.Dz + \varepsilon$$

where y is per capita household income and ε is the error term. Fi are dummy variables representing different categories of farming households where i = 1 represents households where fish farmers have been trained and/or who use fertiliser in their ponds (a proxy for use of BMPs), referred to here as fish farming type A. Households where fish farmers have not been trained and do not use fertiliser are represented by i = 2 and referred to as fish farming type B. Non-fish farming households are represented by i = 0. X is a vector of household demographic and socio-economic explanatory variables and D is a vector of dummy variables representing household characteristics.

Data and methods for assessing indirect poverty impacts of aquaculture

The indirect poverty impacts of small-scale pond aquaculture and SME cage aquaculture are assessed using: data from the household survey of small-scale pond farmers; fish farm budgets estimated with four groups of small-scale pond fish farmers using the method of participatory budgeting (Dorward *et al*., 1998); a survey of 14 small-scale and 5 medium-scale cage farm enterprises) in two districts in Eastern Region[3]; focus group discussions (FGDs) with 7 communities located around cage farm clusters; and key informant interviews.

A fixed-price semi input-output multiplier model developed by Bell and Hazell (1980) is used to estimate the potential economic multiplier effects arising from development of small-scale pond and SME cage aquaculture in Ashanti and Eastern

[3] Asuogyaman and Lower Manya Krobo districts.

regions respectively. The model considers the effects of production and consumption linkages on economic growth. The model describes an economy where gross output consists of tradable output *T*, assumed to be fixed at T as tradable goods are assumed to be supply constrained, plus nontradable outputs, N, the supply of which is assumed to be highly elastic.

Both regional and national definitions of trading space are used to calculate regional (local) and national multiplier effects. Commodities are classified as tradable or nontradable depending on whether they are imported or exported from the trading space (i*.e.* Ashanti/Eastern Region or Ghana) or have any locally available substitutes whose prices are correlated with them. While farmed fish produced by small-scale pond farmers in Ashanti Region are generally not traded outside the region let alone the country, and while cage farmed tilapia are traded outside Eastern Region but not exported, aquaculture products are treated as tradables as they have locally available tradable substitutes (fish from local marine and inland fisheries and imported fish) whose prices are correlated.

The model measures the impact on a region's income of an exogenous shock to a sector, via technological change or outside investment, enabling the region to increase its output of tradables and causing the output of nontradables to increase. The multiplier (*M*) can be written (Delgado et al., 1998):

$$M = \frac{1 - a_{nn} + a_{nt}\left(\frac{\mathrm{v}_n}{\mathrm{v}_t}\right)}{1 - a_{nn} - \beta_n \mathrm{v}_n\,(1 - \mathrm{s})}$$

where:

a_{nn}, a_{nt}	=	the share of nontradable intermediate inputs in nontradable and tradable output respectively (between 0 and 1)
a_{tn}, a_{tt}	=	the share of tradable intermediate inputs in nontradable and tradable output respectively (between 0 and 1)
v_n	=	a constant with a value equal to 1 - a_{tn} - a_{nn}, the share of value added in gross output of the nontradables sector
v_t	=	same as v_n but for tradables, with value equal to 1 - a_{tt} - a_{nt}
β_n	=	marginal propensity to consume nontradables (the marginal budget share (MBS) of nontradables)
s	=	leakage, a constant proportion of total income (savings and tax rate)[4].

This model is used to estimate the regional and national economic multiplier effects (*i.e.* the effect on regional and national income) of a one dollar increase in income from:

i) small-scale pond aquaculture in Ashanti Region, and

ii) SME cage aquaculture in Eastern Region.

The model assumes an elastic supply of nontradables and thus no price increases when demand for nontradables increases due to increased income from a shock to the tradables sector. This is unrealistic however and suggests the multiplier estimates are an upper bound: an overestimate of up to 30 percent compared to price endogenous models (Haggblade *et al*., 1991; Delgado *et al*., 1998). Therefore the multiplier estimates presented below have been revised downward by 30 percent to account for inelastic supply of nontradables

[4] The multiplier and parameter definitions are taken directly from Delgado et al. (1998).

Parameter estimation

a_{nn} is estimated from a previous study of agricultural multipliers in Ghana by Al-Hassan and Jatoe (2007). a_{nt} is estimated from the participatory budgets of small-scale pond farmers and budget data from the SME cage farmer survey. v_n is estimated from Al-Hassan and Jatoe (2007), and v_t is estimated from primary budget data. s is estimated at 0.185 (18.5%) from Ghana National Accounts data (GSS 2011), however this is likely to be an overestimate as the Ghana Living Standards Survey 5 (GLSS5) implies there is dis-saving (GSS, 2008). To estimate likely ranges a savings rate of zero is also used. β_n is calculated by estimating expenditure functions for nontradable goods using expenditure data from the GLSS5. Goods are classified into nationally tradable and nontradable categories. As there was only one pond farmer and no cage farmers captured by the GLSS5, the expenditure of cocoa farmers in Ashanti Region is used as a proxy for expenditure of small-scale pond farmers in Ashanti and the expenditure of professionals from Greater Accra who also had agricultural income is used as a proxy for SME cage farm owners. A variant of the Working-Leser model (Working, 1943, Leser, 1963) is used to estimate the MBS of nontradable goods, using total expenditures as a proxy for income. While there are a number of limitations related to the estimation of parameters which may have an effect on the multiplier estimates, the precise estimates do not matter as much as the *difference* in multiplier estimates for these two aquaculture systems.

Additional primary data were collected in August 2013 and November 2014 to verify and supplement findings. A FGD was conducted with 10 small-scale pond farmers in Ashanti Region in August 2013. Key informant interviews were held in 2013 and 2014 with: Fisheries Commission staff from Ashanti and Eastern regions; staff from the Water Research Institute in Accra and Akosombo; Chairman of the Ghana Aquaculture Association, and several SME and large-scale cage farmers in Eastern Region.

5. Results: Actual and potential poverty impacts of aquaculture in Ghana

This section assesses aquaculture's direct and indirect poverty impacts in Ghana. Direct impacts of small-scale pond aquaculture are presented first looking at the: characteristics of small-scale fish farmers; differences in poverty indicators between fish and non-fish farming households; and effect of aquaculture on household income. SME cage aquaculture is unlikely to have direct impacts on poor households due to the high costs of investment and working capital. Indirect impacts of small-scale pond and SME cage aquaculture are then assessed looking at: economic linkages; food security; multiplier effects; and employment generation, followed by an overall comparison of poverty impacts and growth potential for each system.

5.1. Direct poverty impacts of pond aquaculture

5.1.1. Socio-economic and production characteristics of small-scale fish farmers

For aquaculture to directly impact poverty, poor households need to be able to adopt aquaculture. The investment and working capital cost of pond aquaculture is likely to be too high for the average poor farmer. For example, in 2010 it cost GH¢2,000

(US$1,400[5]) to construct a 500m^2 pond in Ashanti Region, higher than Ghana's GDP per capita (US$1,320[6]). Wealth rankings found that a much higher percentage (22%) of households in the highest wealth category undertook aquaculture compared to the medium and less wealthy/poor groups (7% and 6% respectively). Similarly the household survey found a smaller share of the population of fish farmers (44%) was under the US$ 1.25 poverty line than the population of non-fish farmers (57%) (p = .11).

Most small-scale rural pond aquaculture farmers in Ghana are male crop farmers pursuing diversified farm and nonfarm livelihood activities. The majority of fish farmers in Ashanti are primarily cocoa farmers who produce other crops such as cassava and plantain. Some fish farmers, and/or members of their households, are also engaged in one or more non-farm enterprises. Very few fish farmers surveyed (10%) undertake aquaculture as a primary activity.

The main species cultured by nearly all pond farmers surveyed is Nile tilapia, with most producing it in a mixed culture with catfish and a small percentage in a mixed culture with heterotis (*Heterotis niloticus*). Fish farmers surveyed own on average two ponds, approximately 550m^2 each, and harvested one pond in 2010. Poor farmers have smaller ponds than non-poor farmers (410m^2 and 670m^2 respectively).

Most small-scale pond aquaculture in Ashanti is semi-intensive and farmers use mainly local feed such as maize bran and groundnut peel. Only a quarter of fish

[5] June 2010 exchange rate of GH¢1 = US$0.70 available at: http://www.exchange-rates.org/Rate/GHS/USD/6-16-2010 (accessed 3 November 2016).
[6] http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?page=1 (accessed 3 November 2016).

farmers surveyed use commercial feed. Many pond farmers also use organic fertilisers such as poultry droppings bought locally from poultry farms and the market. Only 33 percent of poor fish farmers compared to 56 percent of non-poor fish farmers use fertiliser. Inorganic fertiliser is used by only 7 percent of all farmers (13% and 3% of poor and non-poor farmers respectively).Over 60 percent of fish farmers surveyed had received some aquaculture training, mainly from fisheries extension staff.

On average the pond farmers surveyed harvested 160kg of fish in 2010, with a yield of approximately 2t/ha/yr (1.3t/ha/yr for poor fish farmers and 2.5t/ha/yr for non-poor fish farmers ($p = 0.12$)). Compared to poor fish farmers, in 2010 non-poor fish farmers: harvested over 4 times as much fish (240kg compared to 56kg ($p = 0.013$)), sold over 5 times as much fish (196kg compared to 36kg ($p = 0.018$)), and received over 5 times as much revenue from the sale of fish (GH¢655 compared to GH¢130 ($p = 0.019$)). While the majority of farmers harvested fish in 2010, only 46 percent sold any fish. On average poor fish farmers sold over 60 percent of their harvest (consuming and gifting the remainder) while non-poor farmers sold nearly 80 percent.

Participatory budgets revealed a range of positive and negative profit margins. A key cause of negative profit margins was a lack of technical knowledge regarding stocking density and feeding practices[7]. More in depth studies of the profitability of fish farming in Ghana have been undertaken (*e.g.* Kaliba *et al*., 2007; Asmah, 2008) which suggest small-scale pond aquaculture can be profitable. Nearly 50 percent of

[7] In several groups the stocking rate was very low compared to the 3 fingerlings/m^2 rate recommended by the FC. Feeding practices were also found to be sub-optimal.

the 392 non-commercial pond aquaculture farmers surveyed by Asmah (2008) in Ghana were profitable when all fish produced was valued.

4.2. Poverty impacts of small-scale pond aquaculture

Estimated average household income of small-scale fish farmers is just over GH¢5,120 (US$3,585[8]), 30 percent higher than that of non-fish farmer households estimated at GH¢3,900 (US$2,730) ($p = 0.09$). Fish farming contributed approximately 8 percent to household income for both poor and non-poor fish farming households in 2010. Fish farming households have a significantly higher average household asset index (51) than non-fish farming households (30) ($p = .02$). While differences in household asset index between poor fish and non-fish farming households are not significant, the largest difference was found between non-poor fish and non-fish farming households with asset index scores of 63 and 30 respectively ($p = 0.01$). This suggests there may be an asset threshold over which fish farming allows higher income and asset accumulation and could indicate that fish farming has more potential to increase the wealth of non-poor households above the asset threshold, than poor households below the asset threshold. Key informant interviews support these findings and suggest it is difficult for poor farmers to significantly increase income through aquaculture due to their limited resources, questioning aquaculture's potential to generate significant direct poverty impacts.

No significant differences in frequency of fish or meat consumption were found between fish and non-fish farming households. Poor fish farming households eat fish more frequently than non-poor fish farming households who eat more meat,

[8] GH¢1 = US$0.70.

indicating fish is a more pro-poor animal-source food than meat. Overall fish is eaten by both poor and non-poor households 6 days a week. While the amount of fish eaten was not measured, there is little difference in FCS between fish and non-fish farming households suggesting aquaculture has limited direct impact on food security.

The results of the IDM (Table 2) suggest that when controlling for other factors, fish farming type A is likely to increase per capita household income by 54 percent while fish farming type B is unlikely to increase income at all. As expected, larger households have lower per capita income, households located in Amansie West District appear to be better off than those in the other two districts and households with larger farm sizes have slightly higher incomes.

Table 2: Parameter estimates of the Income Determination Model

Variables	Coefficients	SE	T	Sig.
(Constant)	6.404	.284	22.555	.000
Farmer category (base non-fish farmers)				
***F_1* - Fish farmers type A - trained and/or using fertiliser (proxy for BMPs)**	.543	.150	3.616	.000
***F_2* - Fish farmers type B - not trained and not using fertiliser (proxy for no BMPs)**	-.301	.211	-1.429	.155
Household size	-.118	.019	-6.062	.000
Amansie West District	.575	.149	3.857	.000
Total farm size (ha)	.026	.008	3.264	.001
Off-farm income	.334	.131	2.541	.012
Sale of staple crops (plantain and/or cassava)	.256	.135	1.898	.060
Sale of cash crops (citrus and/or oil palm)	.134	.135	.994	.322
Sale of livestock and/or livestock products	.270	.138	1.956	.053
Wealth tercile 1 (lowest)	-.276	.152	-1.813	.072
Wealth tercile 3 (highest)	.339	.151	2.240	.027
Difficulty accessing markets	-.302	.170	-1.775	.078
Households who faced a crisis or shock	-.339	.166	-2.039	.044

Number of years in an association	-.244	.076	-3.208	.002
Number of years in an association, squared	.027	.011	2.515	.013

Notes: Dependent Variable: Log of per capita income
Number of observations = 141
R^2 = .471, Adjusted R^2 = .407, F = 7.405 (p = .000)

Although the tests for endogeneity and selection bias indicate no problems in the model, it is not possible to categorically state that fish farming type A causes income to increase. While fish farming type A is likely to increase incomes of non-poor fish farmers, it appears that fish farming may have lower impacts on income of poor fish farmers (mainly practising fish farming type B) due to resource and other constraints that make them less likely or able to use BMPs.

The descriptive analysis suggests an asset threshold over which fish farming allows income and capital accumulation. A significant relationship exists between income poverty status and fish farming type, which may also indicate a threshold in BMP use. The IDM and descriptive analysis together therefore suggest that while fish farming type A, practised mainly by non-poor farmers (over the BMP and asset thresholds) increases income, poor farmers (under the BMP and asset thresholds) are less likely or able to participate in fish farming type A. Thus while small-scale fish farming is likely to have a positive impact on income and wealth of non-poor type A farmers, it is unlikely to have much impact on poor farmers, unless they can overcome their resource constraints and engage in fish farming type A.

5.2. Indirect impacts of aquaculture in Ghana

The presence of positive direct impacts from fish farming type A suggests that indirect poverty impacts should also be present. The remainder of this section assesses the actual and potential indirect impacts of financially viable small-scale pond aquaculture (fish farming type A) in Ashanti Region and SME cage aquaculture in Eastern Region on poverty and economic growth through: economic linkages; multiplier effects; food security; and employment effects.

5.2.1. Indirect impacts of small-scale pond aquaculture

Backward linkages from small-scale pond farming (type A) are strong due to the high proportion of nontradable inputs. These inputs are mainly fingerlings and local feed, and some fertiliser and lime, which are produced and consumed within Ghana. Forward linkages are weaker for pond aquaculture than SME cage culture. Most pond farmers sell fresh unprocessed fish directly to consumers at the farm gate. However, there is potential for forward linkages to be stronger with increased aquaculture adoption as growth of fish supply would require increased processing, trading and marketing activities. These activities would likely be carried out mainly by women who already dominate most fish processing and trading activities. Estimates of the MBS of small-scale fish farmers for regionally and nationally nontradable goods in Ashanti Region indicate that for every extra dollar of income earned by farmers from small-scale pond aquaculture, 44 percent will be spent on regionally nontradable goods and services and 62 percent will be spent on nationally nontradable goods and services, implying strong consumption linkages.

In many of the rural communities where small-scale pond farms are located, the majority of fish available is processed (smoked and dried) and comes from the coast or from inland fisheries. Supply of fresh fish is irregular and does not meet demand at prevailing prices. Key informant interviews suggest that these communities benefit greatly from cheaper and increased supply of fresh fish when fish ponds are harvested. The majority (57%) of all fish and non-fish farmers surveyed indicated that fish farming has increased fish supply in the community. At present however, due to the small number of ponds and long production cycles (between 6 months and 2 years), harvesting is infrequent. However, as households spend a significant proportion of their income on fish, the potential for small-scale pond aquaculture in rural communities to increase fish supply, reduce prices and improve local food security is strong.

5.2.2. Indirect impacts of SME cage aquaculture

Small-scale cage farm owners are mainly professionals from Accra who have established cage farms for investment, not as primary livelihood activities. These farm owners are well educated and relatively well resourced however their level of technical and market information is variable. Key informant interviews suggest there is a high turnover of small-scale cage farms. This could partly be due to the lack of experience and expertise of farm owners, and because they leave farm management to often untrained and casual labourers, leading to low productivity and profitability. However as the pool of trained cage farm workers is increasing (partly through high staff turnover at large-scale farms) and workers and farm owners are gaining experience, small-scale cage farms may also be doing better. A number of medium-scale cage farms are owned by expatriate entrepreneurs with good technical knowledge, and for whom fish farming is their primary occupation. Unlike small-scale farms, the majority of medium-scale cage farms employ some trained staff, have good access to technical and market information and have strong bargaining positions relative to buyers. While the characteristics of small- and medium-scale cage farm owners are different, they are grouped together here as SMEs as their indirect impacts on poverty via economic linkages are likely to be similar due to their similar production systems, given equivalent increases in scale.

SME cage farming has much weaker backward linkages than pond aquaculture. Fingerlings and feed are cage farming's main inputs and while fingerlings are nontradable, produced and consumed within Ghana, commercial feed comprises the majority of costs. While the main feed supplier Ranaan has established a feed mill in Ghana and produces feed locally, there are a number of imported feed substitutes whose prices are correlated with Ranaan's, thus commercial feed is classified as tradable and does not contribute to the multiplier effect. Other nontradable inputs include cages which are generally produced locally, though this represents a very small proportion of costs.

SME cage aquaculture has stronger forward linkages than small-scale pond aquaculture. Many small-scale cage farms and the majority of medium-scale cage farms sell directly to retailers including cold stores, hotels and restaurants. Most cage farmed fish is distributed to markets in Accra and other urban centres by a network of primarily female fish traders, some of whom also trade in wild caught fish from Lake Volta. Very few traders are from communities located around cage farms as farmed fish is not sold on credit unlike wild caught fish. The majority of SME cage farms sell to traders and wholesalers and most cage farms also sell to consumers. The same network of traders and wholesalers buy fish from all the SME and large-scale cage farms on Lake Volta. It is estimated there were 20 wholesalers and over 200 traders within this network in 2013 (plus 400 traders who buy from the wholesale and retail outlets of Tropo Farms – the largest cage farm in Ghana - in Accra). This network is increasingly steadily with key informant interviews suggesting the number of traders increased by 30 percent between 2011 and 2013. All fish is sold fresh and unprocessed, and scaling and gutting is undertaken at the farm on harvest days by women from local communities paid by customers, mainly traders. This creates regular casual employment for poor women from local communities.

The MBS estimates suggest that 37 and 49 percent of each extra dollar of income earned by small-scale cage farmers would be spent on regionally and nationally nontradable goods respectively. This suggests lower consumption linkages than from small-scale pond farmers which is expected as wealthier cage farm owners are likely to spend a larger proportion of their income on imported or tradable goods. Labour represents a low proportion of input costs and value added for SME cage farms, so consumption linkages are largely from farm owners. The impact of consumption linkages may not be felt by local communities around cage farm clusters as the sector is still very small and consumption linkages are mainly from farm owners, most of whom live in Accra. The impact of consumption linkages are more apparent in the communities located around the medium (and large-scale) farms by virtue of their size and the number of workers they employ.

Communities near SME cage farms could potentially benefit from cheaper and increased fish supply during harvests, especially given the declining fish catch from Lake Volta (Béné, 2007). However, due to the relatively small number of functional cage farms and 6 month production cycles, small-scale cage farm harvests are infrequent. FGDs with communities close to small-scale cage farms indicate limited impact on local fish consumption. Some community members are able to buy small sized tilapia on harvest days as they are cheaper and in lower demand than larger sized tilapia. Small-scale cage farms are also more likely to produce a higher proportion of smaller fish than medium- and large-scale cage farms due to their lower technical knowledge, lower financial resources to pay for commercial feed throughout the production cycle and their tendency to harvest early. Thus local communities surrounding medium-scale farms are less likely to benefit from increased fish supply as the larger fish they produce are too expensive for local consumers. Several medium-scale farms do not sell to community members either selling direct to wholesalers or at retail outlets in Accra and elsewhere.

Generally in Ghana tilapia is a high value fish demanded by better off consumers whereas poorer consumers eat cheaper wild caught fish such as ‘one man thousand’ (*Sierrathrissa leonensis*) and catfish (*Clarias spp.*) from inland fisheries and herring (*Sardinella spp.*) from the sea. Nationally there seems limited potential at present to decrease fish prices through increased production of cage farmed tilapia. As noted above, aquaculture production was estimated to be between 20,000t and 32,000t in 2013, most of which was tilapia. Kaunda *et al*. (2010) estimate annual tilapia demand to be 60,000t to 120,000t and argue the market can absorb a substantial increase in tilapia supplies without leading to major price reductions.

However, while high priced cage farmed tilapia currently puts it out of reach of most poor consumers, this could change as production increases, prices fall and incomes rise. It has been estimated that the real price of tilapia is decreasing having reached a peak of US$4.56/kg on average in 2009 (Frimpong & Anane-Taabeah, 2014). The market is already showing signs of slowing down: farmer interviews suggest cage farmers have had difficulties selling fish, particularly higher priced large tilapia, indicating the high-value market segment is beginning to saturate at current prices. The preferred size of fish is also decreasing with traders no longer demanding more expensive fish of 400-500g but rather fish between 250-350g. However at present, cage farmed tilapia is a high value product whose price is related to other high value fish products. Therefore, increased supply will not necessarily decrease its price or benefit the poor until the current high demand for fish is met or production costs reduce.

5.3. Comparison of multiplier effects between aquaculture systems

The potential regional and national multipliers from small-scale pond aquaculture (type A) are estimated to be between 1.6 and 1.8, and between 3.0 and 3.5 respectively. Approximately 50% of these multiplier effects are from consumption linkages. The potential regional and national multipliers from SME cage aquaculture are estimated to be 1.1, and between 1.5 and 1.6 respectively. Approximately 70 percent of the regional multiplier effect and 60 percent of the national multiplier effect are from consumption linkages. These results mean that an extra dollar of income from small-scale pond aquaculture is estimated to generate between US$0.6 and US$0.8 of further income within the region and between US$2.0 to US$2.5 of further income nationally. An extra dollar of income from SME cage aquaculture is estimated to generate US$0.1 of further income within the region and between US$0.5 to US$0.6 of further income nationally. These estimates reflect the potential multiplier effects of relatively well managed and financially viable small-scale pond and SME cage farms rather than the actual current multiplier effects given that many pond and cage farms are unprofitable at present.

While economic growth does not necessarily translate directly into poverty reduction, many studies have highlighted the strong relationship between agricultural growth and poverty (*e.g.* Irz *et al*., 2001; World Bank, 2007). For example Irz *et al*. (2001) find that a 1 percent increase in agricultural yields decreases the percentage of the population living under the US$1/day poverty line by 0.91 percent (and by 0.96 percent in SSA). Also, the effectiveness of economic growth in reducing poverty depends partly on the equality of income distribution. If growth is generated by those in higher income groups (such as SME cage farmers) more income growth is needed to reduce poverty than if growth is generated by those in lower income groups (such as small-scale pond farmers) (Lustig *et al*., 2002).

5.4. Employment generation by different aquaculture systems

While economic multipliers include the effect of on-farm and value chain employment, to better understand aquaculture's employment linkages, employment generated by small-scale pond and SME cage aquaculture are compared. On average fish farming type A is estimated to generate 0.2-0.3 full time equivalent (FTE) jobs/farm depending if pond construction is included, while small- and medium-scale cage farms are estimated to generate 4 and 24 FTE jobs/farm respectively. All employment generated by small-scale pond farms is suitable for unskilled, poor, rural wage labourers. All employment generated by small-scale cage farms and 70 percent of employment generated by medium-scale cage farms are suitable for unskilled labourers to be trained on the job. Medium-scale farms have been expanding production and interviews with two medium-scale cage farmers suggest employment per farm approximately doubled between 2011 and 2013.

Small-scale pond aquaculture has an undeveloped value chain and currently does not create much indirect employment along the value chain. The SME (and large-scale) cage farm value chain is more developed and has created indirect employment opportunities for workers in feed mills and hatcheries, for poor local women who process fish and fish traders. The majority of indirect employment created by the cage sector is for low income female traders who buy from the SME and large-scale cage farms and sell to hotels, restaurants, and consumers. The results suggest at least one indirect job is generated in the value chain for cage farmed fish for each direct job generated on-farm.

While the small-scale pond aquaculture sector does not create as much direct and indirect employment as the SME cage sector, given equivalent increases in investment and scale this might not be the case. For example it is estimated that small-scale pond farms generate 0.3 FTE on-farm jobs/US$1,000 invested (including pond construction) while small-scale cage aquaculture generates approximately 0.1 FTE on-farm jobs/US$1,000 invested and is likely to be lower for medium-scale farms. While these estimates are only approximate, they indicate that if employment generated by pond construction is included, small-scale pond aquaculture could potentially create more employment per dollar invested than SME cage aquaculture. Similarly, the multiplier estimates above suggest that small-scale pond aquaculture (type A) could potentially generate more economic growth (and indirect employment), than SME cage farming, given equivalent increases in scale.

5.5. Summary of poverty impacts and growth potential of different aquaculture systems

The direct and indirect impacts and linkages from small-scale pond and SME cage aquaculture systems are summarised in Table 3. Scores are assigned to each impact or linkage from each system to indicate its current strength as follows: weak (1), medium (3) or strong (5). The potential of linkages to impact on the poor are also scored using this scale. While some of the impacts on the poor have been reviewed in this paper (*e.g.* the direct impact of small-scale pond aquaculture on income and food security) the poverty impacts of indirect linkages such as the economic linkages and multiplier effects from different systems have not been quantified. Rather the likely impact on poverty is inferred from the strength of the linkage, supplemented with knowledge of the characteristics of the likely beneficiaries and the broader literature.

Overall, small-scale pond aquaculture (type A) has stronger direct and indirect impact pathways and is also likely to have higher potential to impact on poverty than SME cage scale farming given equivalent increases in scale. However the small-scale pond aquaculture sector is less dynamic in terms of growth and requires more support than the SME sector to develop. Thus, the table does not tell the whole story.

Table 3: Summary of the strength of impacts and linkages from small-scale pond and SME cage aquaculture systems

Impact	Small-scale artisanal pond aquaculture (fish farming type A)		SME commercial cage farming	
Direct impacts	**Strength of impact**		**Strength of impact**	
Increased income of poor adopters	1		0	
Increased food security of poor adopters	2		0	
Indirect impacts	**Strength of linkage***	**Likely strength of impact on the poor****	**Strength of linkage***	**Likely strength of impact on the poor****
Backward linkages	4	3	1	1
Forward linkages	1	1	2	1
Consumption linkages	4	4	3	3
Economic multiplier effect	4	3	2	1
Direct employment opportunities	3	3	1	1

Notes:

Scoring:
Positive: weak (1), medium (3), strong (5)
Negative: weak (-1), medium (-3), strong (-5)
None (0)

Kassam (2013) found limited growth potential for the small-scale pond aquaculture sector due to high transaction costs influenced by factors including: geographical dispersion of farmers producing low volumes over long production cycles leading to volume uncertainty and value chain coordination problems; high costs for disseminating information, marketing and transportation due to scattered supply; and high perishability and lack of cold storage facilities increasing producers' risk and reducing their marketing options once fish is harvested. While elements of limited market development were also found in the small-scale cage aquaculture sector, Kassam (2013) suggests there is good potential for further growth of the SME sector due to: the higher socio-economic status of SME owners, their increased access to market and technical information, the relative proximity of cage farms to input markets and lucrative output markets in and around Accra, and the expected high returns compared to risks.

The potential impacts on poverty and growth potential together constitute a necessary and sufficient set of conditions for pro-poor aquaculture development. Individually each of these conditions is necessary for pro-poor aquaculture development but neither is sufficient on its own. Table 4 scores the performance of each aquaculture system on these dimensions.

Table 4: Summary of poverty impact and growth potential of different aquaculture systems in Ghana

	Small-scale, artisanal, pond aquaculture systems		Commercial cage aquaculture systems	
Contribution to pro-poor development	**Fish farming type B (poor farmers)**	**Fish farming type A (non-poor farmers)**	**Small-scale**	**Medium-scale**
Direct poverty impacts	1	0	0	0
Indirect poverty impacts (multiplier effects)	0	4	2	2
Current growth potential	1	2	3	4

Notes:
Weak (1), medium (3), strong (5)
None (0)

These results suggest that the highest potential for aquaculture development poverty impacts in Ghana does not reside with small-scale, artisanal, pond aquaculture (fish farming type B) undertaken by poor farmers (with very limited growth potential despite potential direct poverty impacts) nor with commercial cage aquaculture undertaken by SMEs (with limited poverty impacts despite medium to strong growth potential). Instead it is the ‘intermediate’ aquaculture system, classified here as small-scale, artisanal pond aquaculture (fish farming type A), practised by non-poor farmers, that holds the greatest potential – as a result of its strong indirect poverty links and low but nevertheless important potential growth impacts if the constraints to growth can be addressed by supportive investment. While these results show potential effects for equivalent increases in scale of investment, Table 4 also shows the greater potential for growth among SME cages than pond aquaculture. At present the absolute size of the impact of SME cages on Ghana's economy is significantly larger than that of small-scale pond aquaculture and this gap is likely to keep widening without supportive investment for fish farming type A.

6. Discussion

The findings above suggest that non-poor, small-scale pond fish farmers in Ghana, commonly categorised as ‘non commercial’, have a higher poverty impact potential than ‘commercial’ SME cage farms. These findings support the current move away from a narrow focus on poor producers. However, it is unclear whether the arguments for expanding support to include commercial SMEs (Brummett *et al*., 2008; Beveridge *et al*., 2010; Little *et al*., 2012) are fully supported. The extent to which these findings support the paradigm shift depend critically upon the: i) definition and categorisation of different types and scales of fish farming; ii) importance of multiplier effects; iii) growth potential of different systems; and iv) objectives of aquaculture development policies and interventions.

6.1. Challenges of definition

The classifications in the aquaculture literature focus on broad categorisations such as ‘commercial’ or ‘non commercial’ (Ridler and Hishamunda, 2001; Moehl *et al*., 2006), and extensive, artisanal, SME or large-scale (Brummett *et al*., 2008). Each category encompasses farm types that differ in scale and intensity, level of hired labour and purchased inputs, production, market orientation and motivation. Consistent application of these categories in different contexts is difficult – as the Ghana case illustrates.

Moehl *et al*. (2006) define 'non commercial' farmers as farmers with ponds with various motivations including producing fish for home consumption. 'Commercial' farmers are primarily fish farmers who produce for profit. While the small-scale farmers surveyed are farmers with ponds with diversified livelihood strategies, their primary motivation is also profit therefore it is unclear which category they belong to. Asmah (2008) estimated 97 percent of fish farms in Ghana were 'non commercial' based on criteria from Ridler & Hishamunda (2001). The majority of small-scale fish farmers surveyed here, both types A and B, are most likely to be defined as 'non commercial'.

These ambiguities are also reflected in the characterisation of artisanal farmers by Brummett *et al.* (2008) as those that: have a small number of ponds constructed and operated with family labour, use few purchased inputs, have low productivity, sell a small proportion of production and generate minimal profits and economic growth. The characteristics of the *poor*, small-scale farmers analysed here correspond more closely with Brummett *et al*.'s artisanal farmers than those of the *non-poor*, small-scale farmers. These non-poor farmers however also do not resemble commercial SMEs characterised by Brummett *et al*. (2008) and lie in-between these two categories.

Little *et al*. (2012) note that definitions based on scale reveal contradictions. Belton *et al*. (2012) argue for a ‘relations of production’ approach defining aquaculture in terms of relationships (‘quasi-peasant’, ‘quasi-capitalist’ and ‘capitalist’) to overcome these contradictions. While overall these categories correspond to the definitions of commercial orientation discussed above, they incorporate a wider range of characteristics including use of hired labour, motivations, and aquaculture’s place in farmers’ livelihoods, and situate farms in various value chains. Belton *et al*. (2012) found ‘quasi capitalist’ aquaculture may have stronger potential to reduce poverty than ‘quasi-peasant’ aquaculture in Bangladesh. Using this typology, both poor and non-poor small-scale pond farmers in Ghana fall under the ‘quasi peasant’ (similar to ‘non commercial’) rather than the ‘quasi capitalist’ (similar to ‘commercial’) category[9], though some type A farmers fall between the two due to their use of hired labour.

Figure 2 locates the different categories of fish farmers analysed here within commonly used classifications, to illustrate these ambiguities.

[9] Small-scale pond aquaculture corresponds to ‘quasi-peasant’ aquaculture (poor type B farmers fit in the low intensity group and non-poor type A farmers fit in the moderate intensity group). Small-scale cage aquaculture corresponds to ‘quasi capitalist’ aquaculture (moderate or intensive intensity) and medium-scale cage aquaculture corresponds to ‘capitalist’ aquaculture (moderate or high intensity).

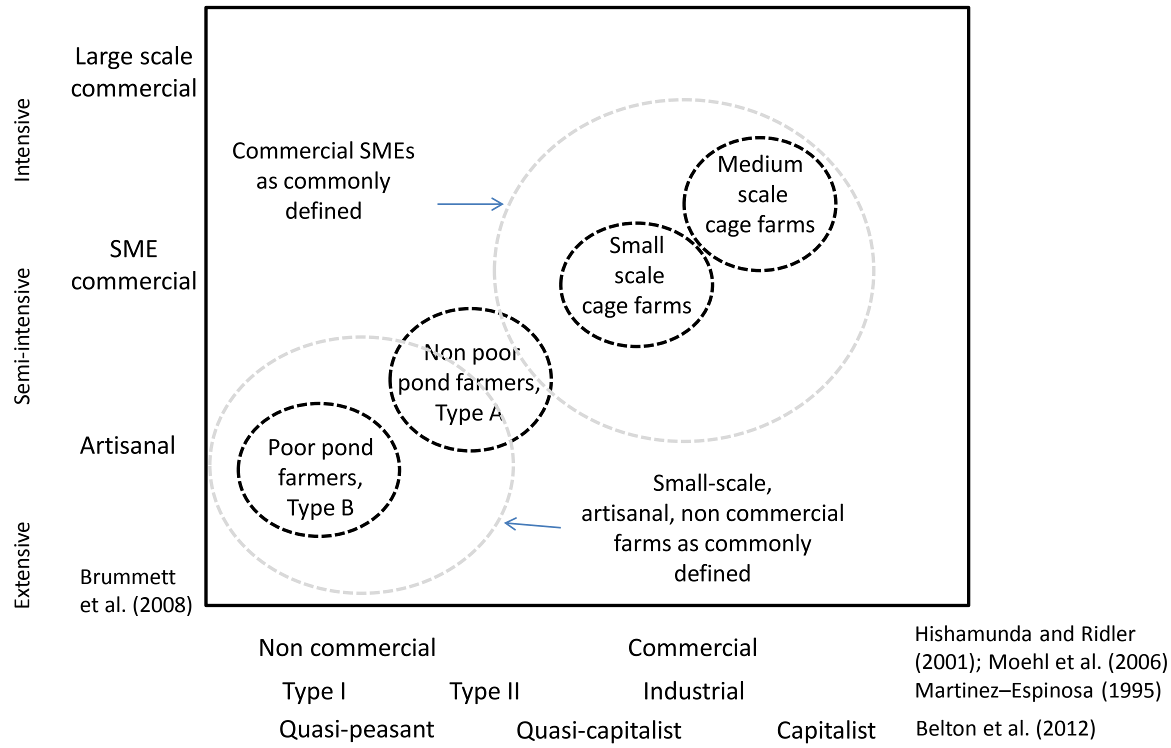

Figure 2: Definitions of aquaculture systems and fish farmer categories

Non-poor, type A pond farmers are located between: artisanal and SME; ‘non commercial’ and ‘commercial’; and ‘quasi-peasant’ and ‘quasi-capitalist’ categories, overlapping more with artisanal, ‘non commercial’, ‘quasi-capitalist’ categories. The classification by Martinez-Espinosa (1995) of Type I and II rural aquaculture representing the ‘poorest of the poor’ and ‘less poor’ respectively appears to correspond best with the poor and non-poor small-scale farmers reviewed here However, the poorest of the poor are unable to adopt aquaculture in Ghana and almost all farmers surveyed aim to increase profit and do not treat aquaculture as a subsistence activity unlike Type I farmers. Figure 2 shows that non-poor type A farmers, who have been found here to hold the greatest poverty impact potential, do not fit neatly into the standard ‘commercial’ category which the emerging paradigm is moving towards. If however fish farming type A farms are categorised as 'commercial micro enterprises' then the findings support the paradigm shift.

The categories commonly used to characterise aquaculture systems and farmers are likely to cause confusion when targeting development interventions. They are also a source of ambiguity between our findings and the emerging paradigm. In reality farmers are located along a continuum and the classification of aquaculture systems and farmers will differ between contexts. Relying on broad classifications to target aquaculture development efforts risks overlooking systems and farmer categories with high poverty impact potential. A more nuanced approach, which accounts for the wide spectrum of farmers whose characteristics and needs differ between contexts, is required.

6.2. The importance of economic multiplier effects

The shift towards supporting 'commercial' farmers may not only be a response to the apparent failures of past efforts to develop the small-scale 'non commercial' aquaculture sector, especially given the majority of farming households are likely to be driven more by the desire to generate income than by development programmes, but is also in line with changing paradigms in the wider development sector. Gibbon & Schulpen (2002) in Belton & Little (2011), refer to this as the current private-sector development consensus among multilateral and bilateral institutions based on the understanding that economic growth (needed for poverty alleviation) is best achieved through facilitating private sector development (*e.g.* World Bank, 2007).

The shift towards 'commercial' aquaculture development appears to be influenced by this general development trend and is thus partly based on the view that 'commercial' SMEs and 'quasi capitalist' enterprises have more potential to reduce poverty through generating value chain employment and economic growth than 'non commercial', 'quasi peasant', artisanal aquaculture (Brummett *et al*., 2008; Belton *et al*., 2012; Little *et al*., 2012). This argument does not, however, appear to be based on evidence of the relative importance of potential economic multiplier effects of different aquaculture systems. While there have been an increasing number of studies recently showing the potential of aquaculture to create on-farm and value chain employment (*e.g.* Faruque, 2007; Irz *et al*, 2007; Macfadyen *et al*., 2011; Belton *et al*., 2012) there are no studies estimating aquaculture's economic multiplier effects. Therefore, though the paper's findings are in agreement with broadening support beyond poor fish farmers, they also question the shift towards 'commercial', SME, 'quasi-capitalist' fish farms on the basis that they create higher indirect poverty impacts, when there is no evidence that this fish farmer category has the potential to generate larger multipliers than others.

6.3. Institutional innovation

The findings above support the general trend towards a broader value chain perspective for aquaculture development. This perspective is important not only due to the benefits of value chain employment generation, but also due to the importance of making simultaneous and complementary investments along the value chain in order for aquaculture systems to grow and hence realise their potential to impact on poverty (Kassam, 2013). The potential for aquaculture systems to grow is related to the potential of producers to intensify and/or expand their operations and systems to attract new entrants. While non-poor Type A farmers may have the greatest poverty impact potential, the small-scale artisanal sector also faces the highest constraints to growth. This is due to the high transaction costs faced by actors within the small-scale sector and their lack of financial and social resources to overcome these costs (*ibid.*). Thus despite its potential for poverty impact in Ghana, supporting the small-scale artisanal sector would appear much more challenging and expensive for donors and governments than supporting the SME sector where farmers have higher resource levels to overcome constraints, are less dispersed and are already linked to growing urban markets. Therefore, there is more convergence between the findings above and the move towards 'commercial' aquaculture when systems' relative potential for growth is considered. While the small-scale artisanal sector may face the greatest challenges to growth, if these challenges can be overcome through coordinated value chain development facilitated by institutional innovation, it may still hold the most potential for poverty impact in Ghana.

6.4. Objectives of policies and interventions to develop aquaculture

There are a number of distinct but overlapping goals for aquaculture development in SSA namely: national food (or fish) security, poverty reduction and local and/or household food security goals. Different systems may be best suited to addressing different goals. For example the findings above suggest that fish farming type A practiced by non-poor farmers has the most potential to generate multiplier effects and reduce poverty. SME (and large-scale) cage aquaculture on the other hand has more potential to increase national fish supplies and face less constraints to growth while fish farming types A and B have more potential to enhance food security of poor households. Donor and government objectives for the aquaculture sector in

SSA usually encompass this range of goals. If projects designed to achieve household food security and poverty alleviation are judged on their ability to increase national fish supplies, they may unfairly be viewed as unsuccessful. If the priority of governments is to increase national fish supplies, targeting support towards commercial SME and large-scale fish farming would be a more appropriate strategy. The key findings presented here and their implications for aquaculture development are summarised in Figure 3.

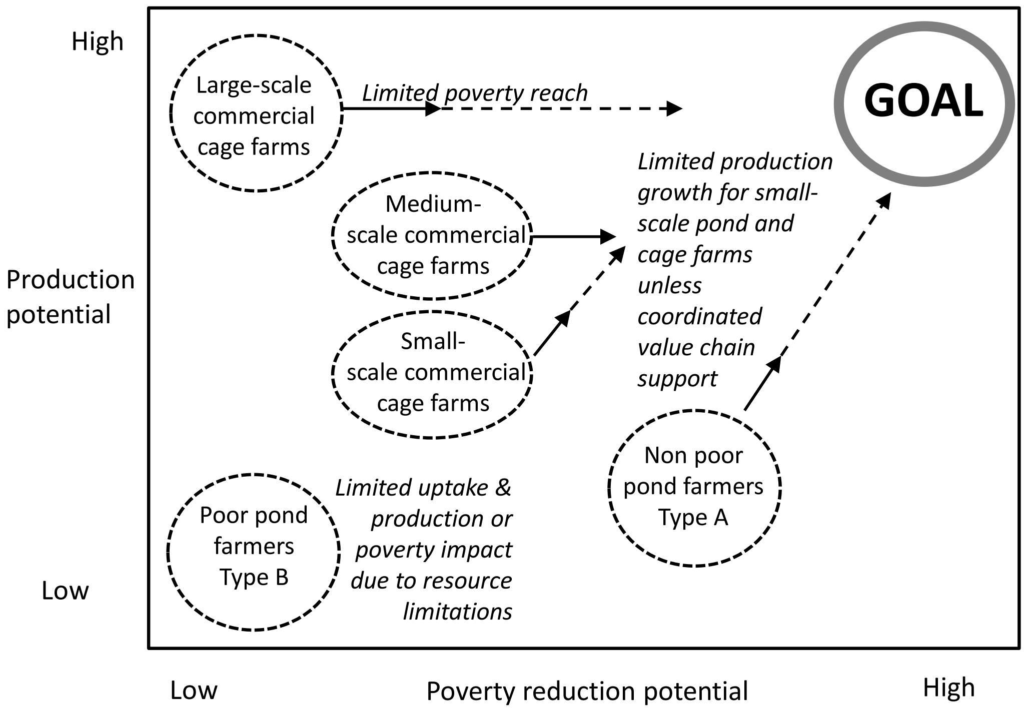

Figure 31: Potential of different aquaculture systems to reduce poverty and increase production in Ghana

Figure 3 illustrates the potentials of the different aquaculture systems to increase production and reduce poverty in Ghana. Poor Type B fish farmers have the least potential to reduce poverty or increase national fish production (though they can potentially increase household food security) especially given most potential fish farmers would not adopt aquaculture unless it generated a more attractive economic return than alternative livelihood options. Non-poor Type A farmers have the highest potential to reduce poverty but less potential to increase national production, though both potentials would increase with coordinated value chain support. Small-scale cage farmers have low to medium potential to increase fish production and reduce poverty however their potential to increase national fish production would increase through value chain development. Medium-scale cage farmers have medium potential to increase production and low to medium potential to reduce poverty. Large-scale commercial cage farmers have the highest potential to increase national fish production but low potential to reduce poverty, unless they develop institutional innovations to benefit small-scale farmers for example through contract farming.

While our findings support the emerging paradigm's view of the limited poverty impact potential of poor aquaculture producers, there remains some ambiguity around the category of fish farmer with the most potential to reduce poverty through indirect impact pathways. To correctly identify and target the systems and farmer categories with the highest poverty impact potential in different contexts, the following areas require increased emphasis and clarity:

i) farm classifications which are relevant across aquaculture systems and contexts need to be improved;

ii) aquaculture systems and farmer categories targeted for support should have the potential to generate the strongest economic multiplier effects; and

iii) institutional innovation and coordinated value chain development are required for aquaculture systems to grow and realise their potential to impact on poverty, economic growth and local and national food security.

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