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Value-chain analysis — An assessment methodology to estimate Egyptian aquaculture sector performance ☆

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ABSTRACT

Egypt's aquaculture production (705,490 tonnes in 2009) is by far the largest of any African country and places it 11th in terms of global aquaculture production. The aquaculture sector in Egypt is now a mature one having developed over a period of more than 30 years, but the financial performance of the sector is not well understood or documented, even though value-chain analysis provides a methodological tool to do so. To provide a better understanding of the sector, a WorldFish Center study completed in September 2011 and funded by the Swiss Agency for Development and Cooperation, conducted a value-chain analysis of the pond fish farming sector. The sector concentrates on the production of tilapia with additional production of mullet, catfish and carp from earthen ponds. The study mapped the value-chain and showed that there is no processing and virtually no export of farmed fish, a short time-period from harvest to final consumption by the consumer (typically around one day) due to the live/fresh nature of all sales, and very low rates (<1%) of post-harvest losses. Quantitative data were collected for each link in the value-chain on operational and financial performance (e.g. gross output values, variable and fixed costs, operational and net profit margins, value-added generation), and on employment creation (by gender, age and full-time/part-time). The results showed that the industry generates a combined LE 4619 ($775) of value-added (i.e. profits plus wages/earnings) for farmers, traders and retailers for each tonne of fish produced. Employment generation is also significant with around 14 full-time equivalent jobs generated for every 100 tonnes of fish produced. However, the sector as a whole is under increasing financial pressure. Critical factors impacting on the performance of the value-chain relate to inputs (most importantly to rising feed costs and the poor quality of fry), to production (most importantly to poor practices with regard to feed management, farm design and construction, fish health management, and stocking densities), and to the marketing, transportation and sale of product (most importantly to declining fish prices in real terms, consumer preference for wild fish and a distrust of filleted/processed products, fluctuating seasonal prices, poor hygiene and handling practices, the lack of value-addition through processing, and the lack of exports). This paper highlights the benefits of value-chain analysis as a useful tool to understand sector performance and argues for its wider use in identifying critical factors and actions to support aquaculture sector improvements.

1. Introduction

The main sources of fish production in Egypt include marine fisheries, inland capture fisheries and aquaculture. Total production increased from 724,300 tonnes in 2000 to 1.1 million tonnes in 2009. These increases were primarily obtained from significant increases in aquaculture production, and the share of total production provided by aquaculture had risen to 65%, up from 47% in 2000 (GAFRD, 2011).

Egypt's aquaculture production was 705,490 tonnes in 2009 (GAFRD, 2011), which is the largest of any African country. According to FAO statistics (FAO FISHSTAT) Egypt ranks 11th in terms of global aquaculture production. Eighty-four percent of aquaculture production comes from earthen ponds, with the rest produced in fish/rice fields,

Abbreviations: LE, Egyptian pounds (LE1 = $5.96); FTE, full time equivalents; Av., average; g, grammes; FCR, Feed Conversion Ratio; BMPs, Best Management Practices; Fed, Feddan (1 ha = 2.381 feddan).

☆ All authors listed above were part of the study team which planned and executed the fieldwork which generated the data and information used and presented in this paper.

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and intensive cage farms (GAFRD 2011). Aquaculture production is strongly concentrated in the delta region to the north of Cairo. Tilapia (*Oreochromis niloticus*) accounts for 55.5% of national aquaculture production by volume, grey mullet (*Mugil cephalus*) and thinlip mullet (*Liza ramada*) for 29.9%, common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), and silver carp (*Hypophthalmichthys molitrix*) for 10.5%, North African catfish (*Clarias gariepinus*) for 2.5%, and European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) for 1.5% (GAFRD 2011).

With a production of over 700,000 tonnes in 2011 and more than 120,000 people estimated to be employed in the sector[2] Egyptian aquaculture makes an important contribution to income, employment creation and food security, all of which are national policy priority areas given low per capita income levels (LE1 2556 or $2107 in 2010),[3] a population that has been growing in recent years at a constant rate of about 1.48 million per year, worsening food security indicators, and official unemployment levels which have remained at around 10% for the last ten years (CAPMAS, 2011).

However, despite the fact that the aquaculture sector in Egypt is now mature, having developed over a period of more than 30 years, the financial and social performance of the sector are not well understood or documented. This is a little surprising given the existence of value-chain analysis as a useful tool to assess performance, and its increasing prominence as a form of analysis in the fisheries and aquaculture sectors (Veliu et al., 2009; Christensen et al., 2011). The increasing interest in value-chain analysis is due to the fact that it provides an excellent means of assessment to:

- Focus on distributional issues and pro-poor and gender equitable growth (Mayoux and Mackie 2008; Rubin et al., 2009; USAID 2011), and on global linkages in the context of globalisation;
- Benchmark changes over time;
- Assess the relative importance of factors affecting competitiveness, and the costs and earnings of those involved in the value chain;
- Identify gaps/weaknesses in value chain performance; and to
- Identify 'levers' and targeted action programmes to 'upgrade' and improve value chain performance.

This paper presents the outputs of a value-chain study completed during September 2011. The study was funded by the Swiss Agency for Development and Cooperation and completed by a team from the WorldFish Center and CARE Egypt, supported by an international expert in value-chain analysis.

The objectives of the study were to better understand, and report on, the pond fish farming value-chain in Egypt. In particular the study aimed to:

- Map the value-chain for pond farmed fish to describe the main stakeholders and the flow of product through the value-chain;
- Consider the employment generated by the sector;
- Understand the costs and earnings profiles and financial performance of the different sub-sectors/links of the value-chain; and
- Identify the key constrains and problems impacting on different actors in the value-chain.

This paper focusses on presenting the results of the first three of these bullets, and only presents in summary form some of the key constraints and problems identified during the study as impacting on the value-chain.

[2] Figures estimated by the General Authority for Fisheries Resource Development.

[3] Most financial/economic figures in this paper are provided in Egyptian pounds (LE). LE 1 = US$ 5.96.

2. Material and methods

2.1. Study scope

The scope of the study presented in this paper was limited to earthen pond farming (which accounts for 85% of the total Egyptian aquaculture production) in four governorates, which together account for almost 74% of the total national production from ponds, namely: Kafr el Sheikh, Behera, Fayoum and Sharkia (see Fig. 1). Pond farms in Egypt are generally considered as 'semi-intensive', although there are a range of different strategies used by fish farmers in terms of stocking densities and the use of feed.

The mapping and financial analyses of the pond farming value-chain start at the fish farm and finish with retail sales to the consumer, with fish fry/fingerlings viewed as a farm input along with other key inputs such as fish feed, labour, capital etc. Hatchery operations and the quality and quantity of fry being produced were considered by the study in terms of the critical challenges and problems facing the sector, but costs and earnings data for hatcheries were not collected as part of the study. The study was also limited to the retail sector, and did not cover the food service sector (e.g. restaurants).

All data on the financial performance of the value chain collected and presented in this paper pertain to the full calendar year 2010, and are yearly averages. The data for each link in the value-chain presented for the four governorates covered by the study are averages, and hide nuances in performance between individual operators.

2.2. Study phases

The study was completed in three main phases.

During the first phase, two study questionnaires covering both qualitative and quantitative issues were drafted, one for fish farmers, and one to cover the post-harvest sub-sector i.e. traders/wholesalers and retailers. The two questionnaires were then piloted at the WorldFish Center office in Abbassa with one fish farmer and one fish trader/wholesaler. This piloting resulted in some small changes to the questionnaires, which were then finalised and printed for the field work.

In Phase 2, individual interviews and focus group discussions were held with fish farmers, traders/wholesalers, and retailers. In order to maximise the number of interviews possible during the time available for the field work, the study team (the authors of this paper) arranged to meet small groups of stakeholders at a central location in each governorate. This provided an opportunity to introduce the study and to hold a focus group discussion in plenary before individual interviews with those participating in the focus groups were then conducted with the participants (each member of the study team sat with a different participant and went through the questionnaire). The introductory comments and focus group discussions, which concentrated mainly on key stakeholder problems and potential solutions, generally lasted around 60 to 90 min, as did the individual interviews.

Table 1 provides information on the number of individual questionnaires completed in each of the four governorates and the number of participants that were involved in the focus group discussions.

During Phase 3, data from the questionnaires were entered into a Microsoft Excel spreadsheet and then analysed to generate the results. The quantitative results were considered in light of, and informed by, the qualitative focus group discussions which had also taken place during Phase 2.

3. Theory/calculation

3.1. Value-chain analysis

A value chain is a sequence of related enterprises conducting activities so as to add value to a product from its primary production,

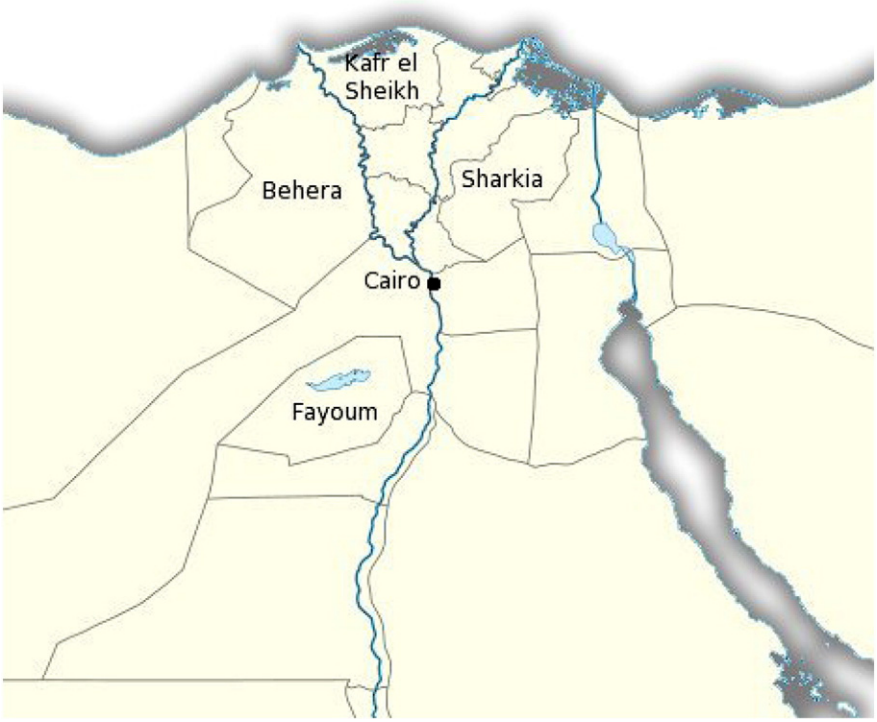

Fig. 1. Map of the study area.

through its processing and marketing to the final sale of the product to consumers. The functions of each link in the chain involve sourcing inputs, making/producing, and then delivering/selling product to the next link in the chain.

Value chain analysis seeks to understand and describe the enterprises involved in the value-chain and their financial performance. Value chain analysis was first popularised by Michael Porter in the mid-1980s (Porter, 1985), and forms of analysis with many similarities have been undertaken since then by others (Womack and Jones, 1996 on value-streams, and Gereffi et al., 2005 on power relations in value-chains). However, it is only more recently that value chain analysis has become increasingly mainstream in development circles.

An important component of value-chain analysis is recognition that support and action for improving performance throughout the value chain can be achieved both by those within the value chain itself i.e. the private sector operators, and by those outside of it i.e. typically governments. For businesses in the chain, they can improve performance by reducing costs, increasing output, and/or increasing the prices of their products (see Riisgard et al., 2010 for more information on ways to upgrade the value-chain). Typically mechanisms to do so involve being more efficient at what they do, and improving the quality or form of product being sold to the next link in the value chain. Improvements in value chain performance can also be supported by governments and other parties external to the value chain. For example, policy, institutions and infrastructure all impact on the ability of businesses in the value chain to source the inputs that they need, to make or engage in their primary activity, and then to sell and deliver their product to their customers. Governments may therefore have an impact on value-chain performance through their influence on policy, subsidies, licensing, standards, transport infrastructure and related costs, property rights, enforcement of regulations, government charges/rent collection, and other impacts on factor costs (e.g. labour, capital, land, utilities).

3.2. Calculations

The data collected during the study have allowed us to estimate a number of key indicators for each link in the value chain. For each link in the value chain the indicators were calculated both separately for each of the four governorates by taking averages of the data provided by the respondents in each governorate, and for the sample frame as a whole.

Table 1
Sample frame used during the study.

Governorate	Fish farmers	Fish traders and/or wholesalers	Fish retailers	Total
Kafr el Sheikh	22 questionnaires 1 focus group with 9 1 focus group with 7 1 focus group with 8	6 questionnaires 1 focus group with 8	5 questionnaires	33 questionnaires Focus group discussions with 32
Behera	14 questionnaires 1 focus group with 15	5 questionnaires 1 focus group with 9	–	19 questionnaires Focus group discussions with 24
Fayoum	16 questionnaires 1 focus group with 29	4 questionnaires	7 questionnaires	27 questionnaires Focus group discussions with 29
Sharkia	9 questionnaires 1 focus group with 12	6 questionnaires	1 questionnaire	16 questionnaires Focus group discussions with 12
Totals	61 questionnaires 6 focus groups with total of 80	21 questionnaires 2 focus groups with a total of 17	13 questionnaires	95 questionnaires 8 focus group discussions with a total of 97

The financial indicators calculated include: gross output values per kg (i.e. prices); operational profits[4] in LE per tonne of fish produced or sold and as a percentage of sales; net profits[5] in LE per tonne of fish produced or sold and as a percentage of sales; total net value-added[6] per tonne of fish sold; and the percentage of the total operational profits, net profits, and value-added made throughout the chain derived from the different links in the value-chain. Calculating these indicators was possible because of the detailed questions in the questionnaires which asked for data on sales volumes and values/prices, operational costs, and fixed costs, and which allowed for the construction of costs and earnings models for each respondent.

Operational costs are those costs which vary depending on the amount of fish being produced. For fish farmers these typically include costs for feed, fertiliser, fry, power, transport, ice, sales commission paid to traders/wholesalers, and labour. For traders/wholesalers and retailers operational costs typically relate to transport of fish from markets, boxes, labour and ice.

Fixed costs are those costs which do not vary depending on production volumes i.e. they need to be paid each year irrespective of production/sales. For the fish farming value-chain, they typically include government licences, repair and maintenance costs, rents paid for land and buildings, and the depreciation costs of assets. Depreciation costs have been estimated by obtaining information on the replacement costs of fixed assets, and depreciating these costs over standardised lifespans for different items e.g. buildings over 25 years, nets over 3 years, water pumps over 5 years, generators over 10 years, vehicles over 10 years.

The study outputs were not just limited to financial indicators however. Individuals were asked to provide information on the number of people employed and on: whether employment is full-time, part-time or seasonal; the number or working days per year for part-time and seasonal workers; whether employees are men or women; whether employees are over or under the age of 30; and where labour comes from. The data collected were analysed and converted into full-time equivalent (FTE) jobs based on the number of days usually worked in the different sub-sectors as reported in our interviews. This allowed for the calculation, for each link in the value-chain (and per governorate), of: the FTE jobs per 100 tonnes of fish sold; the percentage of FTE jobs that are men and women; the percentage of FTE jobs that are full-time as opposed to part-time or seasonal; and the percentage of FTE jobs that are created for those over- and under-thirty years of age.

In addition to these quantitative calculations, the focus groups and some sections of the questionnaires allowed for the collection of more qualitative information, particularly on the key factors impacting on value-chain performance and on some potential solutions to these problems.

4. Results and discussion

4.1. The value-chain for farmed fish from earthen ponds

There are virtually no exports of farmed fish, and so the value-chain is a short and simple one compared to aquaculture value-chains in some other countries. This is especially true given that there is no processing at all of farmed fish i.e. all fish is sold in whole form (either live, fresh on ice, or fresh without ice),[7] and there is no value-addition either through primary processing into fillets or into other secondary processed products (e.g. ready meals, etc.).

Fish is harvested by fish farms (typically but not exclusively between September and December, with stocking having taken place in March/April), bought by traders/wholesalers who either collect fish from the farms or have fish delivered to them by the fish farms, and then sold on to retailers and restaurants (sometimes, but not often, through a second trader/wholesaler). Some product, especially in Kafr el Sheikh, Behera and Sharkia governorates, may pass through wholesale markets, while other product is transported directly by traders/wholesalers to retailers. It appears that much of the largest size-grade of tilapia (>350 g, known locally as 'super') is sold through the wholesale markets in Kafr el Sheikh, Behera and at Al-Obour close to Cairo, while smaller fish may by-pass these market establishments and be sold closer to the farms, where purchasing power of the local population is weaker, and where there is thus a greater demand for smaller and cheaper fish.

Once fish has been harvested, there are no distinct value-chains for different species i.e. individual traders/wholesalers and retailers deal in all fish species, rather than in particular ones. All fish farms reported that they produce and sell a mix of fish species, dominated by sales of tilapia, but also including sales of mullet, catfish, and carp. The average size of fish being harvested is 265 g for tilapia, 409 g for grey mullet, 216 g for thinlip mullet, and 1481 g for catfish. Eighty-nine percent of the volume and 81% of the value of farm production in 2010 covered by our survey were accounted for by tilapia. Mullet represented 9% of farm volumes and 18% of farm values, carp 0.2% of volumes and 0.1% of values, and catfish 1.7% of volumes and 1.3% of values.

All catfish is sold live, while other species (tilapia, mullet, carp) are generally sold either fresh on ice (in summer months or if sales are made relatively far from farms) or fresh with no ice (in winter months and/or if sales are made relatively close to farms). There is a growing trend in the country for the sale of live tilapia. This is particularly the case for tilapia being produced in Fayoum governorate, which is almost all sold live, and transported in drums/tanks with oxygen by traders to wholesaler and retailers. This live fish is typically held in pens/cages in the Nile in Giza and Beni Suef and sold as 'wild' fish from the Nile. In other governorates in the delta, live fish may also be held in irrigation channels, and sold as wild fish, indicating a consumer preference for wild fish over farmed fish.

Interesting features of the value-chain and the flow of product through it include: the very short time-period from harvest to final consumption by the consumer due to the live/fresh nature of all sales, with fish generally sold to consumers the same day as the harvest or the day after; and almost zero post-harvest losses (which is in contrast to many wild fisheries value-chains, where significant post harvest losses often occur in developing countries). These features are reflective of an efficient distribution system and production located close to major areas of population.

4.2. Employment creation through the value-chain

Table 2 demonstrates that in the fish farming sub-sector, employment is entirely male, is fairly evenly divided between those over and under 30 years of age, is more strongly made up of full-time work, and generates 8.3 jobs for each 100 tonnes of fish produced. Non-full time employment is associated with the seasonal nature of some fish farming activities e.g. stocking and harvesting, weed clearance, etc. Seasonal activities on farms e.g. harvesting, are an unskilled activity which can be completed by younger people with fewer skills (at a low cost to the farmers), hence the relatively high rate of employment for the under 30s. Employment creation in Fayoum governorate is probably higher than in other governorates due the small average farm size in this governorate (12 fed), and the resulting inability to generate economies of scale.

[4] Sales revenues less operational costs.

[5] Sales revenues less operational costs and fixed costs.

[6] In national accounts, net value-added is the sum of remuneration of labour plus capital i.e. pre-tax profits to owners net of depreciation, plus wages.

[7] Some tiny quantities of farmed fish may be sold frozen by retailers if they are unable to sell product on a particular day, and deteriorating quality requires them to place fish in home/shop freezers and then to sell it frozen. There is however no mass freezing of product at the wholesale/trading stage of the value-chain.

Table 2
Employment creation in the value chain.

Employment	Kafr el Sheikh	Behera	Fayoum	Sharkia	Overall average
Full time equivalent jobs per 100 tonnes sold					
Farmers	6.99	5.31	12.59	7.98	8.31
Traders/wholesalers	0.40	0.62	0.92	1.56	0.87
Retailers	1.34	n/a	7.79	2.02	4.62
Total	8.73	5.93	21.29	11.57	13.80
% of FTE days contributed by men					
Farmers	100%	100%	100%	100%	100%
Traders/wholesalers	100%	100%	100%	94%	98%
Retailers	60%	n/a	80%	50%	69%
% of FTE days for full-time employment as opposed to part-time or seasonal work					
Farmers	70%	86%	63%	73%	72%
Traders/wholesalers	83%	91%	97%	92%	91%
Retailers	100%	n/a	100%	100%	100%
% of FTE days contributed by those under 30 years of age					
Farmers	71%	41%	52%	56%	57%
Traders/wholesalers	35%	52%	36%	28%	37%
Retailers	50%	n/a	16%	100%	37%

For the trader/wholesaler sub-sector, employment is also almost exclusively male, even more full-time in nature than in the farming sub-sector, and generates a lower percentage of jobs for the under 30s. Employment is generally associated with loading and unloading of fish. The lower percentage of employment for those under 30s compared to the farm sub-sector is probably explained by the fact that traders/wholesalers represent key players in the value-chain, requiring considerable amounts of capital (generally from their own sources) which the young are likely to find less able to provide. The trading/wholesaling sub-sector generates just under 1 FTE job for each 100 tonnes of fish being sold — much lower than for the farming sub-sector due to the short-time traders have the product in their possession and the fact that they are in the business of distribution, rather than processing.

It is only at the retail sub-sector that there are any meaningful quantities of female employment being created, sometimes as managers/owners of small businesses but more commonly as employees. This employment tends to be full-time in nature, and with a low proportion of total employment being for the under 30s, again probably because of the need to have capital and/or facilities to commence such an activity. The retail sector creates 4.6 jobs per 100 tonnes of fish sold.

Data on FTE creation per tonne of fish passing through the value-chain, allow us to estimate that for every 100 tonnes of fish produced by pond fish farms, once the product has travelled through the value-chain, it has resulted in almost 14 FTE jobs being created. For the total production from ponds in Egypt (591,296 tonnes in 2009), a total of around 82,000 FTE jobs can thus be estimated in the sector as a whole at the national level.[8]

For the sector as a whole, and for all sub-sectors within it, almost all labour is sourced from within the governorate in which the business is based. However, our interviews did identify some limited numbers of people, especially from Kafr el Sheikh, who work in other governorates. Wages paid to those working in the sector are typically around LE 800–900/month ($134–151/month) for full-time labour, and LE 30–50/day ($5–8.4/day) for part-time and seasonal labour.

4.3. Fish farming sub-sector — operational and financial performance

Table 3 provides the average operational data for fish farms in each of the four governorates, and average operational data for the sample frame as a whole.

[8] This study did not attempt to estimate multiplier employment impacts from pond farming, or employment from other production methods e.g. cage farming.

Some interesting points to highlight from these results are:

- The relatively low average farm size in Fayoum, explained by the fact that Fayoum is an oasis to the south-west of Cairo, and therefore suitable land for farming and fish farming is less available than in the other governorates;
- The fact that most interviewees have been involved in the fish farming business for many years;
- The relatively uniform stocking size for tilapia (around 10 g), except in Behera where stocking size is lower;
- Feed Conversion Ratios (FCRs) that are similar in Kafr el Sheikh and Fayoum, but not as good as in Behera and Sharkia (which also have similar FCRs to each other). Differences in the FCR rates are likely to be the result of a number of different factors such as: the size of fish at stocking; the extent to which fertiliser is also used; feed management techniques and relative efficiencies; the quality of the feed being used, which varies considerably between farms and governorates; and the extent of water exchange;
- Production per fed that is comparable in Kafr el Sheikh, Fayoum and Sharkia, but highest in Behera. This is perhaps due to fact that many of the fish farms included in the sample frame in Behera are located close to lake Idku, and so water availability and exchange is particularly good in this area;
- Relatively low fish prices in Behera due mainly to a smaller percentage of total production consisting of 'super' (largest) grade tilapia in that governorate, and the relatively high prices in Fayoum due to the dominance of the live fish trade in that governorate;
- Tilapia 'super' prices in Fayoum which are higher than the average price for total production in Fayoum, due to the low percentage of total production consisting of mullet compared to other governorates — because mullet prices are higher than prices for tilapia, in other governorates mullet production means that the average price for all production is higher than the price for 'super' tilapia;
- Stocking densities that are quite uniform across governorates, but which can vary hugely between farms, depending on farming strategies. Stocking rates reported during interviews range between 6000 and 30,000 per fed for tilapia. However most farms stock between 10,000 and 15,000 tilapia per fed; and
- Fairly consistent average size of fish at harvest in the four governorates.

Table 4 provides information on the financial performance, and the costs and earnings, of the fish farms.

Key points of interest from the results are:

- The positive financial performance in all governorates in terms of average net profits (LE 247,172), net profits per tonne of fish (LE 2329), and net profits as a percentage of sales (22%). Fayoum is the best performing governorate even though it has the highest production cost per tonne, due largely to the high prices of fish paid for their live product. Other reasons may be the level of skills and good management practices in the governorate due to the fact that farmers in Fayoum in particular have been the beneficiaries of considerable amounts of training in the past, and more so than farmers in other governorates. In general farms in Kafr el Sheikh have the worst performance of the four governorates;
- An average total production cost across all farms of LE 7769/tonne, which represents the break-even weighted sales price i.e. the average price of all fish sold by a farm must be more than LE 7769/tonne if the farm is to make a profit;
- The consistently high percentage in all governorates of operational costs which consist of feed costs (67% across all farms). Fish fry constitute the next most important input (13% of operational costs), followed by labour (8%), sales commission (5%), and fuel/electricity/power (3%);
- The high percentage (91.5%) of total costs which consist of operational costs, as opposed to fixed costs. Fixed costs are low due to the

Table 3
Operational data for the fish farming sub-sector.

Operational data	Kafr el Sheikh	Behera	Fayoum	Sharkia	Overall
Total fed of interviewed farms under production	531	448	198	341	1517
Average years involved in the sector	20	18	16	18	18
Average area under production (fed)	25	34	12	38	26
Average size of tilapia when stocking (g)	10	4	11	10	9.05
Average FTE per fed	0.21	0.23	0.38	0.23	0.26
Average FTE per 100 tonnes	6.99	5.31	12.59	7.98	8.31
Average production (tonnes/fed)	3.26	4.81	3.16	3.12	3.55
Average FCR	1.89	1.44	1.71	1.38	1.66
Average sales price (LE/kg (all species))	9.70	8.26	11.79	9.87	9.98
Average sales price tilapia 'super' (LE/kg)	9.59	8.75	11.88	9.34	10.14
Average % of total production from tilapia	86%	94%	93%	79%	89%
Average stocking density tilapia/fed	12,786	17,500	13,656	11,012	13,790
Average stocking density mullet M. Cep/fed	700	784	858	788	776
Average stocking density mullet M. Cap/fed	1600	1354	1466	2167	1676
Average stocking density catfish/fed	200	317	n/a	844	332
Average growth period (months)	9.6	8.7	8.3	7.7	8.7
Average size tilapia at harvest (g)	276	235	283	252	265
Average size mullet M. Cep at harvest (g)	421	342	453	402	409
Average size mullet M. Cap at harvest (g)	223	206	500	177	216
Average size catfish at harvest (g)	1321	1333	n/a	1340	1481

nature of the fish farming business, and also because many farms are on rented land with short lease periods, which decreases the incentive for farmers to invest in fixed assets;

- Land rents are the highest single fixed cost, representing 62% of fixed costs for our sample as a whole, with depreciation, and repair/maintenance costs both contributing 17% of total fixed costs. Very few farms have any formal fixed finance costs in the form of interest payments on loans, as there is virtually no formal bank lending to the sector;
- Total value-added by the sub-sector i.e. net profits plus wages paid to labour, is LE 2989 per tonne of fish produced. Again, this figure is the highest for fish farms in Fayoum.

4.4. Trader/wholesaler sub-sector — operational and financial performance

Table 5 provides the outputs of the data collected and analysed for this sub-sector of the value-chain. Traders/wholesalers are key players in the value-chain, especially in terms of determining prices. The one exception to this is in Fayoum, where fish farmers are reported to have a much stronger influence on farm gate prices than in other governorates (although the influence of traders/wholesalers is still significant in Fayoum also). The traders/wholesalers play a key role in providing finance to many of the fish farms (along with feed mills/traders in many cases), and most of them finance their operations out of their own finance (often earned from other economic activities). This provides an indication of the overall financial position/wealth of such individuals, and their influence in the value-chain. Even though final profit margins (3.9% on average) and profits per tonne of fish sold (LE 422) are both low compared to the farming sub-sector, given the large average value of sales made by individuals each year (LE 11.9 million on average), profits in absolute terms are significant, with individuals typically earning around LE 400,000 per year.

The earnings made by traders/wholesalers are generated from a sales commission, usually of between 3 and 6% on the sales of fish, which is paid to them by the fish farmers. This margin is typically lower (e.g. 3%) when farmers deliver product to them, and higher (5–6%) if a) they collect fish from the farms and therefore have to pay for transportation and ice, and/or b) they have provided finance to fish farmers. Individual questionnaire responses reveal that net profits and net profit margins are generally higher when traders/wholesalers collect fish from the farms, because the costs they incur on ice and transport are less than the difference between the commission they take for collecting fish at the farms, and the commission they get if fish is delivered to them.

Other interesting observations which can be drawn from the data in the table are:

- The higher farm gate price for fish in Fayoum continues to be passed through the value-chain, with higher average prices of fish sold by traders/wholesalers in Fayoum compared to other governorates;
- Average annual sales values for individual traders/wholesalers sold within Fayoum are lower than in other governorates, due to the lower level of total farm production in this governorate;
- Operational 'costs' consist almost entirely of the fish traders/wholesalers buy from farms or sell for them. Other operational cost items include labour, truck rental/transport, ice, and fuel/

Table 4
Financial performance of fish farms.

Financial performance data	Kafr el Sheikh	Behera	Fayoum	Sharkia	Overall Average
Average sales revenue (LE)	804,447	1,385,487	427,841	1,267,517	885,964
Average operational costs (LE)	563,226	1,008,630	286,703	720,814	600,242
Average feed costs as % of operational costs	72%	66%	68%	57%	67%
Average labour costs per tonne produced (LE)	516	486	948	768	660
Average op. costs per tonne produced (LE)	7020	6405	8011	6692	7115
Average operational profit (LE)	253,551	410,652	141,138	546,703	301,357
Average operational profit per tonne (LE)	2724	2243	3402	3179	2997
Average operational profit as % of sales revenue	27%	24%	32%	31%	29%
Average fixed costs (LE)	68,612	52,593	13,498	87,933	51,343
Average total production cost (LE/tonne)	8051	6688	8392	7442	7769
Average net profit (LE)	182,036	356,410	127,639	458,770	247,172
Average net profit per tonne (LE)	1640	1914	3402	2429	2329
Average net profit as % of sales	16%	20%	29%	24%	22%
Average total value-added per tonne (LE)	2155	2400	4350	3198	2989

Table 5
Operational and financial performance data for fish traders/wholesalers.

	Kafr el Sheikh	Behera	Fayoum	Sharkia	Overall
Operational data					
No. of traders/wholesalers interviewed	6	5	5	6	22
Total annual sales value of interviewees (LE)	105,948,000	75,463,200	36,026,210	51,739,588	269,176,998
Average FTE per 100 tonnes of sales	0.40	0.62	0.92	1.56	0.87
Average sales price (LE/kg (all species))	10.83	9.86	12.95	10.23	10.66
Average sales price tilapia 'super' (LE/kg)	10.17	9.67	12.80	10.17	10.5
Financial performance					
Average annual sales value (LE)	17,658,000	12,577,200	7,205,242	8,623,265	11,930,954
Average operational costs (LE)	17,158,250	12,172,752	6,800,911	8,226,058	11,510,701
Average operational profit (LE)	499,750	404,448	404,331	397,206	420,254
Average labour costs per tonne sold (LE)	42	96	98	91	80
Average operation profit per tonne (LE)	293	265	822	413	440
Average operational profit as % of sales	2.6%	3.9%	6.5%	4.5%	4.1%
Average fixed costs (LE)	34,454	13,517	9532	7918	17,377
Average net profit (LE)	465,296	390,931	394,799	389,288	402,877
Average net profit per tonne (LE)	268	252	804	400	422
Average net profit as % of sales	2.3%	3.7%	6.4%	4.4%	3.9%
Average total value-added per tonne (LE)	310	347	903	491	503

power, but none of these items alone comprise more than one percent of the value of sales;

- Fixed costs are generally very low, and more evenly distributed across a range of items such as rents/leases (32% of total fixed costs), depreciation of buildings, fish boxes and vehicles (30% of fixed costs), and repairs and maintenance of buildings and vehicles (15% of fixed costs);
- The individual average earnings for traders/wholesalers across the four governorates appear very consistent, with those in Fayoum similar to those in other governorates even though average total sales values are lower, due to the higher margins being achieved; and
- The average value-added (net profit plus wages) per tonne of fish sold is LE 503, with almost double that being generated in Fayoum.

4.5. Retailer sub-sector — operational and financial performance

There are two main types of farmed fish retailers in Egypt. The first group engages in 'informal' street sales, which take place usually by individual operators who purchase fish from wholesale markets or traders, and then set up shop by the roadside to sell their product. Sales facilities/equipment is minimal, often comprising just a shelter from the sun. Labour is generally not employed, and these types of retailers aim to make LE 0.5–1.0 profit on each kg of fish they buy/sell.

The second group is more formalised, with sales taking place from retail shop facilities, and retailers may also have fridges and or freezers for storing fish if it cannot be sold the same day it is purchased. These businesses often employ labour to clean/prepare fish. As a result their operational and fixed costs tend to be higher than the informal street traders. However, this simplistic description and division is not always entirely accurate or obvious in reality. For example some formal retail businesses may employ people to sell fish (generally of lower quality of or particular species) informally on the street outside or nearby their shop. Equally, many formal retailers also engage in some elements of the food service/restaurant business, and use grills to cook fish for consumers.

The data provided in Table 6 does not distinguish between the two types of operation, due to the small sample size achieved during the study. Nevertheless, some confidence can be gained from the consistency shown in the data between governorates, and the data are interesting in that they show:

- Businesses typically have low fixed costs, and a high percentage of operational costs comprising fish purchases (with other operational costs being primarily for transport of fish from markets, and ice). This suggests that as long as retailers can sell their product for a small standard margin over and above the purchase price, there is little 'risk' inherent in the business;

Table 6
Operational and financial performance data for fish retailers.

	Kafr el Sheikh	Behera	Fayoum	Sharkia	Overall
Operational data					
No. of retailers interviewed	5	0	6	1	12
Total annual sales value of interviewees (LE)	5,244,300	n/a	4,998,210	1,056,600	11,299,110
Average FTE per 100 tonnes of sales	1.34	n/a	7.79	2.02	4.62
Average sales price (LE/kg (all species))	12.51	n/a	15.75	10.67	13.98
Average sales price tilapia 'super' (LE/kg)	10.83	n/a	13.38	11.50	12.19
Financial performance					
Average annual sales value (LE)	1,048,860	n/a	833,035	1,056,600	941,593
Average operational costs (LE)	972,648	n/a	786,268	974,880	879,644
Average labour costs per tonne sold (LE)	0	n/a	333	170	181
Average operational profit (LE)	76,212	n/a	46,767	81,720	61,948
Average operation profit per tonne (LE)	916	n/a	1091	825	996
Average operational profit as % of sales	7%	n/a	7%	8%	7.1%
Average fixed costs (LE)	–	n/a	5557	4700	3170
Average net profit (LE)	76,212	n/a	41,210	77,020	58,778
Average net profit per tonne (LE)	916	n/a	1008	778	951
Average net profit as % of sales	7%	n/a	6%	7%	6.8%
Average total value-added per tonne (LE)	916	n/a	1341	948	1131

Table 7
Gross output values i.e. fish prices for the farmed fish value-chain.

Gross output values	LE/kg (all species basket price)					LE/kg (tilapia 'super' price)					All species basket price as % of final consumer price				
	K el Sh	Beh	Fay	Sha	All	K el Sh	Beh	Fay	Sha	All	K el Sh	Beh	Fay	Sha	All
Farmers	9.70	8.26	11.79	9.87	9.98	9.59	8.75	11.88	9.34	10.14	78%	n/a	75%	92%	71%
Traders/wholesalers	10.83	9.86	12.95	10.23	10.66	10.17	9.67	12.80	10.17	10.50	87%	n/a	82%	96%	76%
Retailers	12.51	n/a	15.75	10.67	13.98	10.83	n/a	13.38	11.50	12.19	100%	n/a	100%	100%	100%

Table 8
Operational profits created in the farmed fish value-chain.

Operational profit	LE/tonne					% of own sales					% of value-chain operational profit creation				
	K el Sh	Beh	Fay	Sha	All	K el Sh	Beh	Fay	Sha	All	K el Sh	Beh	Fay	Sha	All
Farmers	2724	2243	3402	3179	2997	27.2%	24.5%	32.0%	31.5%	28.8%	69.3%	89.4%	64.0%	72.0%	67.6%
Traders/wholesalers	293	265	822	413	440	2.6%	3.9%	6.5%	4.5%	4.1%	7.4%	10.6%	15.5%	9.4%	9.9%
Retailers	916	n/a	1091	825	996	7.3%	n/a	6.8%	7.7%	7.1%	23.3%	n/a	20.5%	18.7%	22.5%
Total	3933	2508	5315	4418	4432										

Table 9
Net profits created in the farmed fish value-chain.

Net profit	LE/tonne					% of own sales					% of value-chain net profit creation				
	K el Sh	Beh	Fay	Sha	All	K el Sh	Beh	Fay	Sha	All	K el Sh	Beh	Fay	Sha	All
Farmers	1640	1914	3402	2429	2329	15.8%	20.4%	28.8%	23.8%	21.8%	58.1%	88.4%	65.2%	67.3%	62.9%
Traders/wholesalers	268	252	804	400	422	2.3%	3.7%	6.4%	4.4%	3.9%	9.5%	11.6%	15.4%	11.1%	11.4%
Retailers	916	n/a	1008	778	951	7.3%	n/a	6.3%	7.3%	6.8%	32.4%	n/a	19.3%	21.6%	25.7%
Total	2824	2166	5215	3607	3702										

- Higher prices for fish in Fayoum exhibited in earlier links in the value-chain are maintained in the retail sub-sector;
- Average net profits per individual business owners are LE 58,778, still considerably above national average earnings; and
- The retail sector creates an average of LE 1131 for every one tonne of fish sold.

4.6. Summary data on financial performance

Mapping the value chain and constructing costs and earnings models for each link in the value chain as presented above, allows for a comparison across the various sub-sectors in the value chain.

Table 7 shows how the average price of product both for all sales sold by each link the value-chain (i.e. the basket price), and separately for tilapia 'super' grade, increases as farmed fish moves through the supply chain in each governorate. It also shows for the basket price of fish the percentage of the final consumer price achieved by each link in the value-chain. The data in the right-hand column of this table show that the farmers are obtaining a relatively high percentage of the final price. This is due to the lack of any exports, the short-supply chain, and the lack of value-addition through the chain.

Tables 8 and 9 show the operational and net profit per tonne respectively for each link in the value chain. These two tables also show the operational and net rates of return on sales values for each link in the value chain, and the percentage contribution of each link in the value-chain to total profits created. The tables show that operational and net profits as a percentage of own sales, and in absolute terms per tonne of fish sold, are highest in the farm sub-sector.

Finally, Table 10 provides information on the total value-added created through the value-chain i.e. the net profit, plus the wages earned by those working in the sector. The data show that on average across all governorates, a total of LE 4619 value-added is generated for each tonne of fish produced by the farming sub-sector. Again, the levels of value-added created are highest in the fish farming sub-sector (LE 2985/tonne), and in Fayoum (LE 6594/tonne).

The data presented in Table 7 to Table 10 serve to benchmark performance by the sub-sectors of the value-chain in different governorates, and demonstrate the superior performance in Fayoum governorate.

Table 10
Total value-added created in the farmed fish value-chain.

Total value-added	LE/tonne					% of value-chain value-added creation				
	K el Sh	Beh	Fay	Sha	All	K el Sh	Beh	Fay	Sha	All
Farmers	2155	2400	4350	3198	2989	63.7%	87.4%	66.0%	69.0%	64.7%
Traders/wholesalers	310	347	903	491	503	9.2%	12.6%	13.7%	10.6%	10.9%
Retailers	916	n/a	1341	948	1131	27.1%	n/a	20.3%	20.4%	24.5%
Total	3381	2748	6594	4637	4623					

The emphasis on live fish trade, on which Fayoum's superior performance appears to be largely based, also seems to be a strategy that is increasingly being pursued in other governorates.

Our fieldwork did not collect information to allow for a quantitative comparison of the changes in performance within the sub-sectors of the value-chain over time in any one governorate (i.e. benchmarking sub-sector performance against itself over time). However we did attempt to generate some findings of a more qualitative nature by asking interviewees to comment on their perceptions about changes in key variables over the last three years. A relatively uniform picture was provided by respondents in terms of the perceived changes in the operational and fixed costs incurred in the fish farming sub-sector, with a dominant view being that most individual cost items e.g. feed, labour, rents, power, etc., have increased over recent years. Given that fish prices have declined in real terms in recent years with only small increases in nominal terms, this would suggest that profitability has been declining in recent years. Sector performance may now be under threat, especially due to increases in the costs of feed, with feed prices having increased by 200–250% over the last 6–7 years.

To the best of our knowledge, a detailed costs and earnings survey of the sub-sectors of the farmed fish value-chain similar to the one presented in this paper has not previously been completed in Egypt. While our data cannot therefore be used to quantitatively assess changes in value-chain performance in recent years, the data obtained during this study may be useful as baseline data to be used for future benchmarking of changes over time. In particular, the data may be helpful in the monitoring and evaluation of any subsequent interventions in support of the sector.

4.7. Critical factors impacting on value-chain performance

In seeking to explore how value-chain performance could be improved, our study qualitatively explored with questionnaire respondents and focus groups the critical factors impacting on value-chain performance. We have chosen in this paper to focus primarily on presenting the financial performance of the value-chain, rather than to discuss in detail the myriad of factors determining value-chain performance. However Table 11 provides a brief summary of the key issues impacting on the sector. All of the issues included in the table represent potential areas of action by the value-chain itself and by those relevant factors outside of it (e.g. government), to improve value-chain performance.

Table 11
Summary of critical issues and factors constraining the sector.

	Critical issue or factor
Input factors	• Access to capital and finance from the banking sector is virtually non-existent, due to perceptions of risk held by the banking sector and the collateral requirements demanded • Feed costs have risen dramatically in the past 6–7 years, and the quality of feed is very variable between feed producers • Fry quality for tilapia is often poor with fry sold as mono-sex reproducing, and in some geographical areas there are shortages of mullet fry • Water quality can be poor from using agricultural drainage water, and availability limited at some times of the year due to agricultural requirements • Expansion of farming into new areas would re quire considerable human capacity development to train labour • Access to land for expansion is increasingly prob lematic, and many farmers operate on land rented from government without any option to buy and with short lease periods and low security of tenure • Power/fuel costs have risen in recent years and many farms do not have access to mains electricity
Production factors	• While the environmental conditions in Egypt are generally favourable for fish production, the colder winter months from January through April place constraints on the fish farming sub-sector, due to the lack of cold tolerance of fish and a growth peri od that is limited to around 8 months • For some farms, pond size, layout and design is not optimal • There is very variable knowledge about Best Management Practices (BMPs) for feed use • Many farms are thought to use sub-optimal stocking strategies • BMPs for fish health management are not always followed • Sector and sub-sector organisation is very weak. Only in Fayoum is there any form of representative organisation that is functioning in a meaningful way • Over-reliance on a small-number of fish species (i.e. tilapia and mullet)
Post-harvest distribution and marketing factors	• Pressure on fish prices due to increasing aquaculture production over the last decade, consumer preference for meat as a source of protein, the presence of significant quantities (although declining) of imports of competitor products (often of poor quality), and a consumer preference for wild fish due to health concerns about fish produced by farms because of water quality issues • Fish prices can exhibit considerable daily and seasonal fluctuations, primarily due to changes in the volume of supply on particular days, or between different months. • Health and hygiene conditions in wholesale and retail markets, and in the transportation/ distribution network are poor • There are virtually no exports, but not enough knowledge about Egypt's competitive position vis a vis other suppliers, about comparative prices in Egypt and in overseas markets, and about the steps that would have to be taken to expand exports, in order to make an informed opinion about the merits of a push to try to access export markets • There is no processing for value-addition, with all fish sold in whole form • Poor road networks to farms in some areas impact on the ability of farmers/traders to get fish to markets

5. Conclusions

Egypt is by far the largest aquaculture producer in Africa and the world's second largest producer of farmed tilapia, and the sector is a pioneering and vibrant one. When one considers the attempts by other African countries to develop aquaculture and the small production volumes that have resulted, the success achieved in Egypt is all the more impressive. This paper has demonstrated that the sector generates very considerable levels of value-added, results in profitable businesses at each stage of the value-chain, and provides employment for many thousands of people (who in turn have many others in their households dependent on their earnings). Most people who work in the sector have been doing so for many years, and our study suggested that this is largely, but not exclusively, due to the sustainable nature of the value-chain rather than due to a lack of alternative livelihood opportunities.

However, the sector now faces a number of significant challenges, and it is noteworthy that the yearly percentage increase in the volume of aquaculture production in 2009 (1.7% above 2008) was the lowest yearly percentage increase for the last 10 years. The historical strength of the sector, coupled with recent challenges, and indeed opportunities for further improvements in value-chain performance, provides a strong argument for action by private sector businesses within the value-chain, and by government in the form of supportive policy and legislation (on issues such as land tenure, access and quality of water, infrastructure, and human capacity development). Such action would serve both to safeguard the current financial and

employment benefits being generated in the sector, and to increase such benefits in the future.

Value-chain analysis has not been widely adopted in the aquaculture sector, with a continuing focus instead in research and interventions on technical production issues. This paper has showed that value chain analysis is a useful tool for understanding the financial and social benefits that are generated by the aquaculture sector, and for identifying the critical factors that affect the financial and social performance of the value chain. Better understanding of these critical factors can inform the necessary actions and innovations to increase the financial and social benefits created by the sector.

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