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Aquaculture Characterization: A Case Study on Marketing Channels in Kafr El-Sheikh Governorate

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ABSTRACT

The study focused on the marketing channels of aquaculture in Kafr El-Sheikh Governorate, located in the Nile Delta of Egypt, with an emphasis on the benefits accessed by actors involved in the value chains. The actors were defined as producers, wholesalers, and retailers. A structured questionnaire was developed and administered through face-to-face interviews to collect data on production systems. Statistical analysis was conducted to examine the socio-economic characteristics of the actors. A significant effect ($P< 0.001$) was found for land ownership, fish shop ownership, and access to transportation facilities. About 35% of producers relied on rented land, while only 6.67% owned their land. Most respondents did not own fish shops; only 18.33% of wholesalers did. Regarding transportation, 78.33% of the respondents reported not having any transportation facilities. Gender also had a significant effect ($P< 0.05$), with 88.33% of the respondents being male. Fish prices ranged from 83 LE/kg at the farm gate, to 87.9 LE/kg at auctions, and 90.5 LE/kg at the retail level. The consumer price was recorded at 95.93 LE/kg at the final outlets. Net profit, calculated as the difference between the average sale price and total costs per kilogram, was 37.76 LE for producers, 51.47 LE for wholesalers, and 66.38 LE for retailers. Profit margins were 73.3% for retailers, 58.55% for wholesalers, and 45.49% for producers. The results of the study highlight the need to enhance producers' capacities through targeted guidance and training programs. Providing actors with access to marketing information is fundamental to improving marketing efficiency, as it enables them to better understand the value gained throughout the production cycle. The government's role in price stabilization and market oversight is seen as a decisive factor in managing gross margins across the value chain. It is recommended that government initiatives focus on developing market infrastructure and addressing environmental impacts to support a long-term vision for exporting fish products.

INTRODUCTION

Aquaculture is considered a vital strategy to meet local needs for fish production. Due to the deterioration of natural fisheries in seas and lakes, aquaculture has taken a crucial role in optimizing the use of production inputs—mainly water—since it relies on agricultural drainage. This dependency has led officials to explore strategies to secure freshwater availability.

According to **FAO (2024)**, Egypt's aquaculture accounts for 67% of the total African fish production, amounting to 1.552 million tons, and ranks 11th globally in aquaculture output. Aquaculture provides employment for more than 36 million people **(Richardson *et al.*, 2011)**. Moreover, it contributes to household incomes, especially in a context of low per capita income and unemployment levels around 10% over recent decades **(CAPMAS, 2011)**.

Approximately 85% of aquaculture production is derived from earthen ponds, while the remaining share comes from fish–rice integrated fields. Tilapia and mullets are the most commonly produced species. Tilapia accounts for 55% of the total aquaculture production, followed by the grey mullets (29.9%), grass carp (10.5%), silver carp (2.5%), and the North African catfish (1.5%) **(MacFadyen *et al.*, 2012)**.

Despite the sector's potential as a sustainable source of employment, marketing constraints remain prominent. Few studies have explored the perceptions and practices along integrated value chains. Challenges in the marketing process include limited equipment, lack of management, inefficiencies in public auctions, and the spread of informal selling. The absence of monitoring systems and insufficient marketing information for stakeholders exacerbates these problems.

Government policies have primarily focused on production, with little attention paid to the marketing side. Key barriers include the lack of reliable records on product prices and trends, and a general decline in marketing services. These issues necessitate the creation of a centralized database that enables beneficiaries to assess and understand their returns.

Marketing gross margins put pressure on both producers and consumers. Producers often earn less than intermediaries or traders, while consumers face rising prices—demonstrating inefficiencies in the marketing chain.

In their study, **Kleih *et al.* (2013)** emphasized the need for research on marketing systems and consumption patterns, along with mechanisms to ensure the safety and affordability of fish products. They also noted the lack of data on aquaculture value chains and the distribution of benefits among actors.

This study aimed to investigate the marketing channels of aquaculture in Kafr El-Sheikh Governorate, a representative region of the Nile Delta in Egypt. It seeked to evaluate the benefits gained by each actor and to estimate the gross margins for producers, wholesalers, and retailers within the aquaculture value chain.

MATERIALS AND METHODS

1. Production systems

The study was conducted at aquaculture farms located in the "El Riad" and "Motobs" districts of Kafr El-Sheikh Governorate. The production systems in the study area were characterized as semi-intensive, utilizing earthen ponds—each covering more than one acre (Fig. 1). Monoculture of tilapia was the predominant farming method, reflecting its strong demand in the local market. According to **Shaheen *et al.* (2013)**, the annual production of semi-intensive systems typically ranges from 5 to 25 metric tons per hectare.

Financial costs in these systems included expenditures on fish feed, fish fry, and labor. Labor costs were categorized into permanent workers, who received monthly salaries throughout the production period, and seasonal workers, who were employed primarily during harvesting.

Fig. 1. Semi- intensive aquaculture systems

2. Actors description

The studied actors were identified as producers, wholesalers, and retailers. The objective was to estimate the benefits gained across these actor groups. A total of 25 producers, 15 wholesalers, and 20 retailers were surveyed. A structured questionnaire was developed and administered through face-to-face interviews to collect data on production systems. The questionnaire also gathered information on socio-economic characteristics, including gender, age, land ownership, type of funding, fish shop ownership, transportation facilities, and perceived constraints to aquaculture from the respondents' perspectives.

3. Selling and purchasing criteria

Fish produced at the farms were sold at the farm gate, then transferred to public auctions, followed by wholesalers, and finally to retailers—either within traditional markets or through retail outlets. This process reflects the short and fragmented nature of the supply chain, making it difficult to clearly define the share or impact of each actor along the chain.

Supply chain integration was considered across technical, operational, and strategic dimensions. Risks encountered along the supply chain influence consumer behavior and affect coordination with suppliers. To enhance the performance of the aquaculture sector, it is essential to identify the critical factors that impact both the social and financial benefits of the actors involved in the value chain.

4. Profitability

4.1 Operational data

To estimate the profitability of the production systems, the following operational indicators were calculated:

- Total fixed costs (LE/kg)
- Total variable costs (LE/kg)
- Full Time Equivalent (FTE) per day

4.2 Financial performance

Financial performance was assessed using the following indicators:

- Average sale price (LE/kg)
- Net profit (LE/kg)
- Profit percentage (% profit per LE/kg)
- Total value added (LE/kg)

5. Statistical analysis

Statistical analysis was conducted using SAS software **(SAS, 2014)**. A Chi-square (χ^2) test **(Snedecor & Cochran, 1993)** was applied to examine the effect of socio-economic traits on the different respondent groups. The traits included:

- S1 = Gender
- S2 = Age
- S3 = Land ownership
- S4 = Type of funding
- S5 = Fish shop ownership
- S6 = Transportation facilities

Respondents were categorized as:

- R1 = Producers
- R2 = Wholesalers
- R3 = Retailers

The model used was as follows:

$Y_{ijk} = \mu + S_i + R_j + e_{ijk}$

Where:

- Y_{ij}: Percentage of respondents
- μ: Overall mean
- S_i: Fixed effect of socio-economic traits
- R_j: Fixed effect of respondent type
- e_{ij}: Random error assumed to be normally and independently distributed NID(0, σ_e^2)

RESULTS AND DISCUSSION

1. Actors traits

Data in Table (1) show a significant effect ($P< 0.001$) of land ownership, shop ownership, and transportation facilities across the targeted actors. Among producers, 35% rely on rented land for aquaculture, while only 6.67% own the land. A total of 53.33% of respondents do not own land, including 20% of wholesalers and 33.33% of retailers.

The majority of respondents did not own fish shops. Only 18.33% of wholesalers reported owning one. Similarly, transportation was largely unavailable; 78.33% of respondents indicated they had no transportation facilities. Among those who did, 15% were wholesalers and 6.67% were producers.

A significant effect ($P < 0.05$) was also recorded for gender, with 88.33% of respondents being male. This reflects the physical demands of aquaculture work and cultural factors limiting women's participation. However, the percentage of women involved in fish retailing reached 10%. According to **Shirajee (2010)**, fish production increased from 10% to 20% when women's participation in farm activities was enhanced.

A substantial portion of respondents (48.33%) were over 50 years of age, indicating a reliance on traditional methods and resistance to adopting modern aquaculture technologies. Most respondents (86.67%) relied on their own funds to support farm operations. Only 3.33% had access to bank loans, while 10% borrowed from neighbors through informal means such as bartering. This supports findings from **Avadi *et al.*, (2022)**, who noted that limited access to bank financing restricts the availability of aquaculture inputs.

The gap in production is attributed to combined factors such as individual capabilities, access to funding, and institutional determinants, especially in developing countries where aquaculture plays a key role in aquatic food systems **(Blasco *et al.*, 2020)**. According to **Pomeroy *et al.* (2008)**, government support through incentives or low-interest loans is essential to promote investment in the aquaculture sector. Furthermore, decision-makers should provide innovation packages to enhance system resilience **(Bush *et al.*, 2021)**.

Effective institutions also play a role in improving access to reliable data, particularly on unregistered or unlicensed hatcheries, which many producers avoid **(Abdel-Hady *et al.*, 2024)**. To build human capacity and promote the efficient use of resources, it is recommended that respondents receive training on aquaculture management practices **(Nasr-Allah *et al.*, 2021)**.

Finally, the sustainability of aquaculture systems must be evaluated in both short- and long-term performance contexts **(Mikkelsen *et al.*, 2021)**.

Table 1. Socio- economic traits of the actors

Variable	Producer	Wholesaler	Retailer	Total	Test	
	%	%	%	%	χ2	Pro.
Gender						
Male	40	25	23.33	88.33	9.92	0.007*
Female	1.67	0	10	11.67		
Age						
From 20 to 30	3.33	0	3.33	6.66	3.88	0.69
From 31 to 40	3.33	1.67	5	10		
From 41 to 50	11.67	10	13.33	35		
>50	23.33	13.33	11.67	48.33		
Land ownership						
Owner	6.67	1.67	0	8.33	50.69	0.001***
Rent	35	3.33	0	38.33		
Without	0	20	33.33	53.33		
Type of funding						
Self financial	36.67	18.33	31.67	86.67	3.77	0.43
Bank	1.67	1.67	0	3.33		
Others	3.33	5	1.67	10		
Shop own						
Yes	3.33	18.33	1.67	23.33	28	0.001***
No	38.33	6.67	31.67	76.67		
Transportation facilities						
Yes	6.67	15	0	21.67	18.99	0.001***
No	35	10	33.33	78.33		

***=P< 0.001, and *=P< 0.05

2. Supply and value chains

2.1. Supply chains

In Kafr El-Sheikh Governorate, fish are primarily sold through wholesale markets before reaching wholesalers and retailers. Large-sized tilapia (over 350g) is typically routed through wholesale markets within the governorate and is then transported to El-Obour Market near Cairo. In contrast, smaller fish are sold closer to the farms, where purchasing power is lower, often resulting in discounted prices.

Tilapia is the dominant species sold, followed by mullet and catfish **(Nasr Allah *et al.,* 2012)**. The fish marketing process is largely controlled by major wholesalers. According to **El Gayar (2003)**, official wholesale markets exist where producers bring their fish to be auctioned daily.

Retailers of farmed fish are generally categorized into two groups: (1) informal street vendors who set up roadside stalls, and (2) formal retail shops equipped with storage facilities. Due to the seasonal nature of Egypt's aquaculture, most of the annual production is supplied to the market within a short timeframe. The fact that fish is sold and consumed primarily in its fresh form reflects the relatively underdeveloped state of the aquaculture supply chain **(MacFadyen *et al.*, 2011)**.

Fig. (2) illustrates the percentage distribution of fish across different marketing routes in Kafr El-Sheikh Governorate.

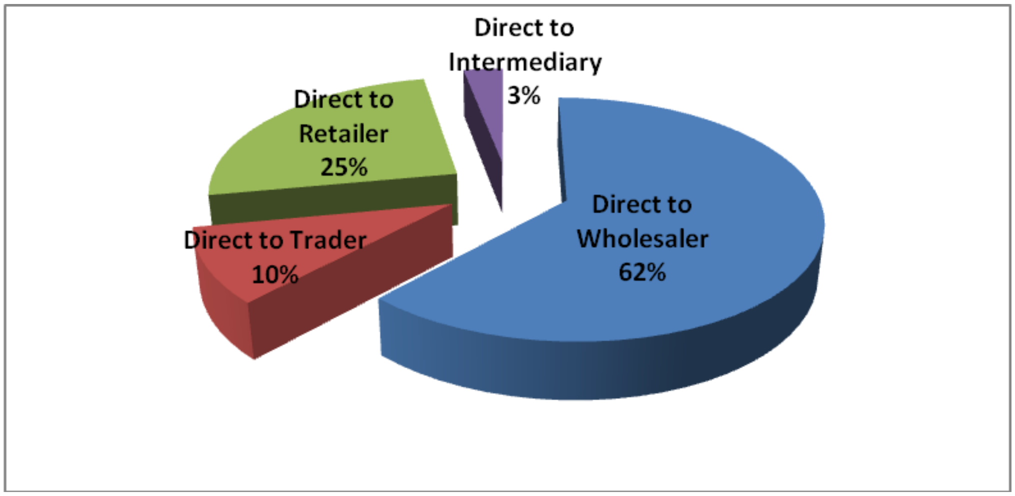

Fig. 2. % of fish marketing destinations

2.2. Value chains

Fish prices vary across marketing stages, beginning at 83 LE/kg at the farm gate, rising to 87.9 LE/kg at public auctions, and reaching 90.5 LE/kg at the retail level (Fig. 3). The final consumer price was recorded at 95.93 LE/kg at retail outlets.

Value chain analysis focuses on identifying the enterprises involved and evaluating their financial performance. Each actor in the chain contributes through specific processes, including input sourcing, production, and transportation of the product to the next link in the chain. These related enterprises add value to the product at different stages—from the primary production phase through marketing and, in some cases, processing—until the product reaches the consumer.

In the case of farmed tilapia, value-added activities are limited. Typically, the fish is transported directly after harvesting to wholesale markets, then distributed to retailers and consumers. Some minor value is added through cleaning and icing, which improves presentation and short-term preservation.

However, quality concerns have been raised. Unhygienic conditions in aquaculture ponds have been linked to potential contamination risks. Factors such as handling, grading, and transportation play a critical role in determining both the nutritional quality and safety of the product **(Ashley, 2007)**.

These factors help explain the relatively low sale price of fish at the farm level, which negatively affects the gross margins of producers and influences the distribution of financial returns among other actors in the value chain.

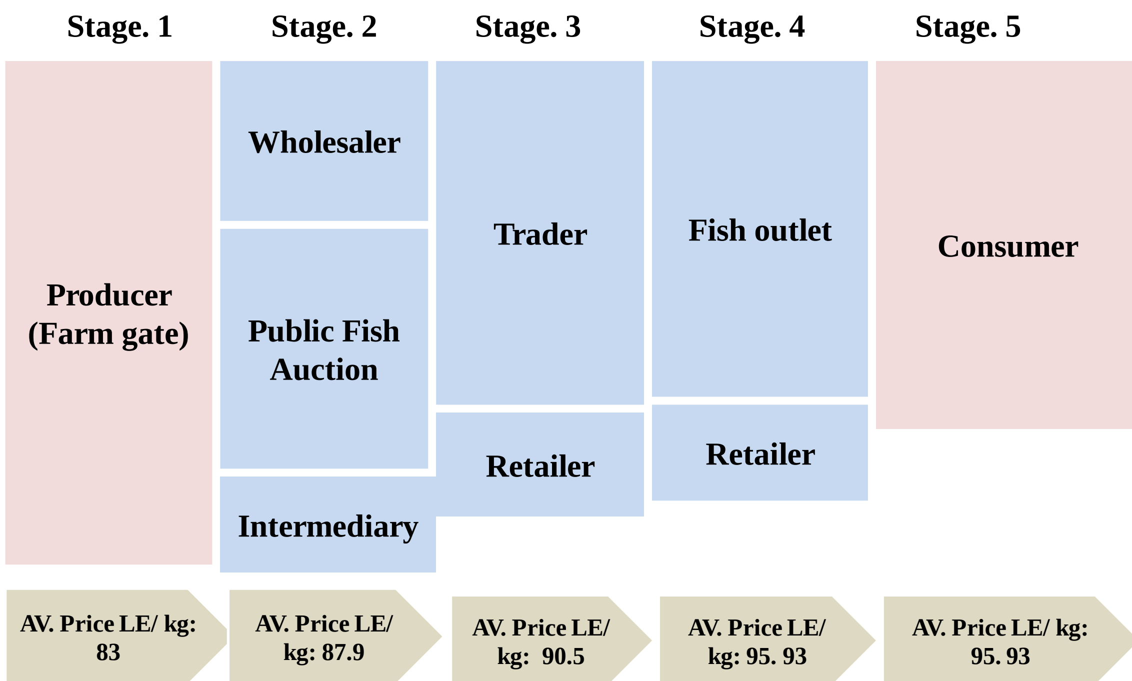

Fig. 3. Aquaculture value chains

3. Profitability

Net profit was calculated as the difference between the average sale price and total costs (LE/kg), ranging from 37.76 LE for producers, 51.47 LE for wholesalers, and 66.38 LE for retailers (Table 2). The highest profit percentage was recorded by retailers at 73.33%, compared to 58.55% for wholesalers and 45.49% for producers.

The higher profitability of downstream actors reflects the shortness and limited integration of the value chain. Value added above the farm gate price amounted to 6% (4.9 LE) at the wholesale level and 9% (7.5 LE) at the retail level, indicating profit accumulation further along the chain.

At the production level, total costs were recorded at 45.24 LE/kg. Variable costs included fish feed, fry, fertilizers, labor, and equipment maintenance. Fixed costs covered land rent, permanent labor, fuel, and housing. For wholesalers, total costs reached 36.43

LE/kg, largely due to transportation and labor expenses. Retailers incurred total costs of 24.12 LE/kg, which included expenses such as ice for fish preservation.

The Full-Time Equivalent (FTE), used to measure labor input in terms of working hours per day, was the highest among retailers (0.667), followed by producers (0.625) and wholesalers (0.417).

Farm size was identified as a factor affecting productivity. Larger farms were associated with lower productivity due to increased risk and greater potential for resource wastage **(Aragón *et al.*, 2022)**. In contrast, higher profits were observed on aquaculture farms practicing intensive polyculture, due to more efficient use of inputs **(Khor *et al.*, 2022)**.

The Benefit-Cost Ratio (BCR) was 1.80 for tilapia raised under semi-intensive aquaculture systems in Kafr El-Sheikh Governorate. The Feed Conversion Ratio (FCR) was reported at 1.23 **(Elsorougy *et al.*, 2025)**. Fish feed quality was found to be a critical driver of productivity. Commercial feed yielded higher profitability compared to homemade alternatives **(Ansah, 2014)**. Additionally, improved feed management was shown to increase household profitability while reducing environmental impacts **(Ahmed, 2007)**.

Table 2. Production systems operational and financial values

Variable	**Producer**	**Wholesaler**	**Retailer**
Operational data*			
Average variable costs LE**/kg	31.74	--	--
Average fixed costs LE/kg	13.5	36.43	24.12
Total costs LE/kg	45.24	36.43	24.12
Full Time Equivalent (FTE)/ day	0.625	0.417	0.667
Financial performance			
Average sale price LE/kg	83	87.9	90.5
Net profit LE/kg	37.76	51.47	66.38
% profit LE/kg	45.49	58.55	73.33
Total value added LE/kg	--	4.9	7.5

*Estimated for one feddan (approximately 4200 m^3) produces 6.5 ton per production period, production period= 9 months
**LE: Egyptian pound= 1/50.6 USD

4. Challenges and opportunities

Aquaculture has been established by the Egyptian government in 1978 on 600,000 acres with 600 hatcheries through semi- intensive culture in brackish water. The sector was supported by Egypt`s extensive coastlines and inland water **(FAO, 2024)**. In 2021, aquaculture reported 3.1 billion USD. Tilapia accounted for 44% of the total aquaculture production value **(FAO, 2023)**. Future Egyptian strategy for aquaculture relies on prudent practice of water resources, adequate trade and marketing, regional and sub- regional cooperation, enhance human potentials. In Table (3), challenges and opportunities associated to aquaculture sector are illustrated.

Table 3. Aquaculture- related challenges and opportunities

Variable	Challenges	Opportunities
1. Production inputs		
- Land	- Reduce area capacity used for aquaculture, decline fish species diversity due to coastal erosion causes water salinity then fishery product reveal threatened.	- Originate for integrated agriculture therefore balance utilization of resources in terms of reducing environmental degradation impact; producers driven to integrated agriculture to improve productivity and preserve systems resilience.
- Water	- The main source of water, which is agriculture drainage emphasized as pollutant; affects quality of fish produced.	- Adaptation of recycling water technology, biofloc systems, aquaponics, extraction of groundwater and desalination; tend to improve lakes alongside natural fisheries.
- Fish feed	- With the expansion of aquaculture industry, limitation of fish meal arises; intensive aquaculture relies mainly on manufactured feed. - High price of feed ingredients due to economic procedure; most of feed ingredients are imported.	- Partial or entire replacement of other unconventional protein sources in fish meal; the track to reduce operational costs then prove income of household.
- Fish seed	- Effect of seasonality that fish fry, particularly Tilapia grows and reproduces better in summer, while in winter season reproduction decreases below the level can cover seed demand from fish farmers.	- Agree a methodology of solar heating enclose breeding in tanks or greenhouse tunnels able hatchery for fish seed; restocking in which potential fisheries or endangered species are being improved.

2. Marketing constraints		
- Fish trading	- Wholesalers access on selling and purchasing operations hence control fish prices; intermediaries involved in marketing criteria based on a commission agreed with the producers lead to non-justification of fish prices.	- Enacting legislation obligating merchants to adhere to the prices set by fish market taking into account prices followed selling and purchasing differences by time.
- Seasonality	- Since fish are produced at a specific time at the end of the production cycle, supply of fish increases, as well fish prices decrease affecting producers` return.	- Diversifying sources of fish products differentiate income throughout the year according to the farm output, whether from fish, crop, animal production.
- Market infrastructure	- Weakness of marketing information expresses difficulty in determining products prices and returns along located value chains.	- Government intervention to improve market infrastructure considering environmental impact, initiate database includes fish type's available, prices information to approach a rewarding return to the producers ensuring sustainability of aquaculture systems.
- Quality issue	- Failure to follow international quality standards and the possibility of bacterial contamination and fish diseases during aquaculture operations.	- Apply sufficient hazard analysis critical control point (HACCP) to grantee that products conform to standard quality specifications, advance products to exportation phase

3. Policies toward improvement		
- Legal activities	- Guarantees for fish farms establishment, registration and respective financial insurance.	- Issuing laws regulating work in fish farming and the related credit element.
- Human potential	- Awareness deficiency of technology among producers; producers often rely on traditional means of breeding.	- Provide guidance programs and campaigns to validate production systems followed to maximize utilization of water resources, feeding management, renewable energy use within framework to conserve environment and prevent wastage.
- Contamination prevention	- Possibility of contamination spread in fish farms due to unclear practices affecting quality of fish fry and growth performance.	- Rising cognitive of legalizing bio- safety aspect, highlighting role of molecular instead of antibiotic to treat fish diseases.
- Financial access	- Poor financial capacity of the producers or the corporate respondents to compensate against any losses resulting from current economic procedures.	- Promote low- interest loans afforded by the government to assist the respondents to cover aquaculture activities.
- Collaboration and partnership	- Subsist gap between executive and relevant bodies including research institutes hinder development mechanisms for advancement of aquaculture industry.	- Supporting linkage between the government and the research institutes, bringing viewpoints of weakness and strengths to achieve a roadmap prove management of aquaculture farms.

CONCLUSION

Aquaculture value chains are primarily composed of three main actors: producers, wholesalers, and retailers. Producers serve as the foundation of the production system, and their capacity can be significantly improved through targeted guidance and training programs. Wholesalers play a critical role in managing the buying and selling of fish at auctions, often setting prices that can restrict price flexibility, thereby impacting profit margins across the value chain. Retailers, by contrast, achieve the highest returns due to their minimal operational inputs—typically limited to adding ice for preservation. The findings of this study highlight the importance of equipping value chain actors with marketing information. Understanding the economic gains at each stage of the production cycle is essential for enhancing marketing efficiency. The government's role in price stabilization and market oversight is a decisive factor in determining gross margins among actors in the aquaculture value chain. Recommendations include the development of market infrastructure and the consideration of environmental sustainability to support a broader vision for fish product export. Such strategic actions should be incorporated into future government policies and initiatives to ensure the long-term success and competitiveness of Egypt's aquaculture sector.

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