Value chain analysis of the Egyptian aquaculture feed industry

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VALUE CHAIN ANALYSIS OF THE EGYPTIAN AQUACULTURE FEED INDUSTRY

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Citation

This publication should be cited as: El-Sayed, A. F.M. (2014). Value chain analysis of the Egyptian aquaculture feed industry. WorldFish, Penang, Malaysia. Project Report: 2014-22.

Acknowledgments

I gratefully acknowledge the many fish feed manufacturers and fish farmers who responded to the questionnaires and willingly provided their information. Special thanks go to Dr. Ismail Radwan (President of Fish Farmers' Association at Kafr El-Shaikh) for facilitating my visits to many fish farms and fish feed mills in Kafr El-Shaikh Governorate. I would also like to thank Dr. Ghada R. Sallam (National Institute of Oceanography and Fisheries, Alexandria) and Dr. Walied Fayed (Faculty of Agriculture, Saba Pasha, Alexandria University) for distributing the questionnaire to, and collecting the results from, many fish farmers and fish feed millers. The information provided by Mr. Karim El-Sharkawi (General Manager of a private aquafeed mill – JOE Trade) and Eng. Ezzat Refai (Cooperative Society for Animal and Poultry Resources Development – West Badrashin – Giza Governorate) is highly appreciated.

LIST OF ABBREVIATIONS

BMP	best management practice
CAPMAS	Central Agency for Public Mobilization and Statistics
CPGAF	code of practice for good animal feeding
EHCFI	Egyptian Holding Company for Food Industries
FFFA	Fayoum Fish Farmers Association
FCR	feed conversion ratio
FAO	Food and Agriculture Organization of the United Nations
FM	fish meal
FTE	full-time equivalent (jobs)
GAFRD	General Authority for Fisheries Resource Development
GUAR	General Union for Aquatic Resources
HACCP	hazard analysis and critical control points
ha	hectare
MALR	Ministry of Agriculture and Land Reclamation
NGO	non-governmental organization
SBM	soybean meal
t	ton(s)
USDA	United States Department of Agriculture

Conversion factors
US$ = EGP 6.96 (Feb 2014)
1 ha = 2.381 feddan

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EXECUTIVE SUMMARY

The commercial aquaculture feed industry in Egypt is growing at a rapid rate. As a result, the number of fish feed mills has increased from just 5 mills producing about 20,000 t per year in 1999, to over 60 mills with a current production estimate of 800,000–1,000,000 t/year.

The performance of the aquafeed industry in Egypt is not well understood, as the value chain structure has not yet been mapped. This study aims to assess the status of the fish feed sector in Egypt, with an emphasis on: mapping and understanding fish feed value chains, describing the main actors and stakeholders within the chain, assessing value chain performance, identifying major strengths and weakness of the sector, and suggesting appropriate actions, management and development strategies.

Two structured questionnaires in English and in Arabic were drafted. They were distributed to fish feed mills and fish farmers. Information was collected from the farmers and feed mills by interview, phone call, email or fax. Twenty-five fish feed mills were interviewed, 17 from the private sector and 8 from the state-owned/public sector. A total of 34 fish farmers, representing a range of production systems and aquaculture areas, were also interviewed.

The results of the study indicate that the value-chain of the fish feed sector in Egypt is relatively simple. It includes four main stakeholder groups/actors: feed ingredients/additives and raw material suppliers; feed producers; feed marketers and traders; and fish farmers.

1. The main constraint facing the fish feed industry and fish farmers is rapidly increasing prices. A large proportion of feed ingredients used in Egyptian animal and aquaculture feeds are imported. In 2011, imports accounted for 99% of soybean cake, 97% of soybean seeds and 50% of maize used or consumed in Egypt. Importation is carried out by a number of private sector importers. Meanwhile, international market prices for key raw materials have risen rapidly in recent years. These factors have contributed to increased prices for fish feed ingredients and fish feeds.
2. An estimated 90% of Egyptian fish feeds are produced by 50 private sector fish feed mills, producing both conventionally pelleted feeds (80–85%) and extruded feeds (15–20%), most of which (85%) are formulated to contain 25% crude protein (CP).
3. The public sector owns 9 mills, producing an estimated 10% of total commercial fish feed production. None are equipped to produce extruded feeds so they only produce conventionally pelleted feeds, usually formulated to contain 25% crude protein (CP).
4. Employment in private sector feed mills was estimated at 29.2 full-time equivalent (FTE) jobs per mill, with an average of 3.9 jobs per 1000 t of feed produced. Employment levels in public sector feed mills were higher (average 90.3 FTE per mill) while productivity was lower (13.3 FTE per 1000 t of feed produced). Based on these calculations, the total full-time number of jobs in fish feed manufacturing is estimated at about 4000–5000 jobs. Males represent 90% of the employees in the public sector and 96.6% in the private sector.
5. An estimated 80% of fish feeds produced by public sector feed mills is sold through traders or retailers, compared to only 15–20% of fish feeds from private sector mills. Fish feed traders and retailers add around 3–6% to the price of fish feeds. Some traders sell feed on credit, with an additional price increase of around 2–4%.
6. Fish farmers stated that feed costs represent around 80% (70–95%) of the total operating costs of their farms. If they purchase feed on credit, they pay 3–6% more and are likely to receive poor quality feed. However, they are forced to do this because they lack access to other sources of credit and financial support. Farmers said they lack basic knowledge about feed and feed management as they do not receive training or quality control inspections.

The study summarized the major constraints facing the fish feed industry in Egypt and proposed the following recommendations for better management and development of the sector:

- reduce dependency on expensive feed ingredients
- improve capacity for production of high quality feeds
- increase employment opportunities in the aquaculture feed sector
- improve access to credit
- improve access to training
- strengthen the legal and policy environment for feed production, quality control, handling, storage and trading.

INTRODUCTION AND BACKGROUND

The Egyptian aquaculture sector has witnessed rapid expansion over the past two decades. As a result, farmed fish production increased from 139,389 tons (t) in 1998, representing 25.5% of total Egyptian fish production, to 1,017,738 t in 2012 when aquaculture production comprised 74% of total fish production (FAO 2013; GAFRD 2013). The area being farmed increased from 42,000 hectares (ha) in 1999 (El-Sayed 1999) to 120,000 ha in 2012 (GAFRD 2013).

Aquaculture expansion in Egypt has been accompanied by a gradual shift from extensive and semi-intensive low-input culture systems to more intensive, feed-dependent systems. This approach has resulted in an increase in demand for commercial fish feeds.

However, the aquaculture feed value chain has not yet been mapped, the key players have not been clearly identified or characterized and the value chain performance is not well understood. This study was designed to address these knowledge gaps with the following objectives:

1. mapping and understanding the fish feed value-chain in Egypt, clearly describing the main actors and stakeholders within the chain, and the roles and interactions amongst them
2. determining value chain performance, in terms of value addition, employment and profitability
3. identifying and synthesizing the strengths and weaknesses of each link of the value-chain
4. suggesting appropriate upgrading, management and development strategies.

Data collection

Two structured questionnaires, one for fish feed producers and one for fish farmers, were drafted by the study team in both English and in Arabic. The draft questionnaires were discussed by the study team, and any necessary modifications made.

In order to avoid a poor response rate, selected stakeholders were first approached by phone, by email, or through trusted intermediaries. They were briefed about the study questionnaire and asked if they were willing to participate in the study. If they agreed, the appropriate questionnaire was administered and completed by project staff or through the trusted intermediaries.

Sampling was designed to reflect all the value chain links and cover factors that might affect value chain performance. For aquaculture feed producers, sampling was designed to:

1. cover most of the geographical areas where aquaculture feed producers are located
2. include a range of small, medium and large producers (from less than 5,000 t/year to more than 30,000 t/year)
3. include private sector and state-owned/ public sector feed mills.

For fish producers, sampling was designed to:

- cover small- and large-scale fish farmers, particularly in the major production governorates
- include a range of production systems: semi-intensive pond farms; intensive farms (tanks, ponds, cages and recirculating systems;) and integrated agriculture/aquaculture farms
- interview farmers of different ages, educational backgrounds and marital status.

Secondary information was collected from various sources, including the General Authority for Fisheries Resources Development (GAFRD), the Food and Agriculture Organization of the United Nations (FAO), the Central Agency for Public Mobilization and Statistics (CAPMAS), aquaculture and aquaculture feed consultants and decision-makers.

Twenty-five fish feed producers were interviewed, 17 from the private sector and 8 from the state-owned sector (Tables 1 and 2; Figure 1). The 34 fish farmers who responded to the questionnaire represented a range of production systems and aquaculture areas (Table 3; Figure 2). The information obtained from the surveys was collated, tabulated and sorted into different categories according to ownership, production capacity and the type of feed produced.

Governorate	Public	Private	Total
Kafr El Sheikh	–	6	6
Beheira	3	1	4
Dakahlia	2	3	5
Sharkia	1	1	2
Giza	–	2	2
Domiat	1	1	2
Gharbia	1	–	1
Alexandria	–	1	1
Cairo	–	1	1
Ismalia	–	1	1
Total	8	17	25

Table 1: Ownership and geographical location of feed mills interviewed

Ownership	Production range (t/ mill/year)					Total
	<5000	5,000–10,000	10,000–15,000	15,000–20,000	>20,000	
Public sector	3	2	1	–	2	8
Private sector	3	4	4	3	3	17
Total	6	6	5	3	5	25

Table 2: Number of feed mills interviewed according to ownership and production capacity

Figure 1: Fish feed manufacturers being interviewed. Courtesy: A.-F.M El-Sayed

Fish farms included semi-intensive, intensive tank, intensive pond and intensive cage culture systems (Table 3). The species cultured included mixed-sex tilapia, mono-sex tilapia and polyculture of tilapia and mullet. The owners were mainly from the private sector.

All data were coded and entered into a Microsoft Excel spreadsheet for statistical analysis, primarily comprising simple descriptive statistics. Tables 1–3 provide information on the number of questionnaires completed by feed millers and fish farmers.

Data validation

Due to significant variability in the data collected for the different variables between state-owned/public feed mills and private mills, the data of these two sub-sectors were analyzed separately. Differences observed between individual responses and between overall financial performance within each sub-sector were minimal. Therefore, data cleaning was not necessary; this means that the quality of data collected was high. This was presumably due to:

- the large sizes of the samples collected, which provided a good representation of the true situation of the aquaculture feed industry (25 feed mills and 34 fish farms);
- the well-designed and simple questionnaires that helped the research team collect all the necessary data and assisted the interviewees in answering all the questions;
- previous experience of the research team in conducting such surveys, and ability to re-question the interviewee when they felt that the respondent's answer might not reflect the reality;
- the fact that the research team was already known to many of the interviewers, indicating a sufficient level of trust;
- a meditator, known to the interviewed stakeholder, who accompanied the research team during the interview to help build trust in certain cases;
- some members of the research team had worked, or were working, as fish feed technicians or fish farm managers/ technicians in the private sector.

Governorate	Semi-intensive	Intensive			Total
		Ponds	Tanks	Cages	
Kafr El-Sheikh	11		1	2	14
Beheira	6	1		3	10
Sharkia	–		1		1
Dakahlia	2				2
Alexandria	2			2	4
Domiat	1			1	2
Port Said	1				1
Total	23	1	2	8	34

Table 3: Number of fish farmers interviewed according to production systems and governorate

Figure 2: Pond farmer (left) and cage farmer (right) being interviewed. Courtesy: A.-F.M El-Sayed

Value chain mapping

Stakeholders

The value chain of the fish feed sector in Egypt is relatively simple. It includes five main stakeholder groups/actors (Figures 3 and 4; Table 4):

1. feed ingredients, additives and raw material providers
2. machinery and hardware providers
3. feed producers
4. feed marketers and traders
5. fish farmers.

Raw materials/ingredients

- Includes: feed ingredients, premixes and feed additives.
- Most feed ingredients are imported. In 2011, 99, 97, 89, 67, 53 and 50% of soybean cake, soybean seeds, sunflower oil, sunflower cake, wheat bran and maize, consumed in Egypt, respectively, were imported.
- Imports are mainly by the private sector.
- A few importers monopolize and control the market.
- Local production of feed ingredients is limited, except for maize and wheat bran.
- Vitamin and mineral premixes, feed additives, antioxidants, etc., are locally mixed or produced.

Feed producers

State–owned/public sector mills

- 9 state-owned/public sector feed mills, producing about 100,000 t/year, about 10% of total market.
- All state-owned/public sector mills produce conventionally pelleted feeds.
- Average sale price US$ 510, profit margin US$ 27/t.
- Permanent labor (FTE) is 90.3 jobs/mill and 13.3 jobs/1000 t of feed produced.

Private sector mills

- Private mills produce pressed (80–85%) and extruded (15–20%) feeds.
- Over 85% of the feed produced contains 25% crude protein.
- Average sale price US$550, profit margin US$ 38/t.
- About 80% of private mills sell their products directly to farmers.
- Feed is sold for cash or on credit. Credit-based selling leads to 3–6% increase in prices.
- Private mills employ 29.2 jobs (FTE)/mill and 3.9 jobs/1000 t of feed produced.
- Average profit is 7%.

Fish feed traders/retailers

- 15% of fish feeds from private sector mills are sold by traders/retailers compared to 70% from state-owned mills.
- Fish feed traders/retailers make about 2-5% profit.
- Some traders sell feed on credit, with an additional increase in the price of about 2-4%.

Fish farmers

- Feed represents 70–95% (85% on average) of total farm operating costs.
- 80% of fish farmers buy feed directly from the mills.
- Small-scale farmers lack access to credit and financial support.
- Many small-scale fish farmers purchase the feeds from producers or traders on credit; however, resulting prices are 3–6% higher and they risk receiving poor quality feed.
- Farmers do not receive capacity building services or quality control inspections.
- Many farmers lack basic knowledge of feeds and feed management.
- The FCR (food conversion ratio) of conventionally pelleted feed is generally higher than for extruded feeds.

Figure 3: The Egyptian aquaculture feed value chain

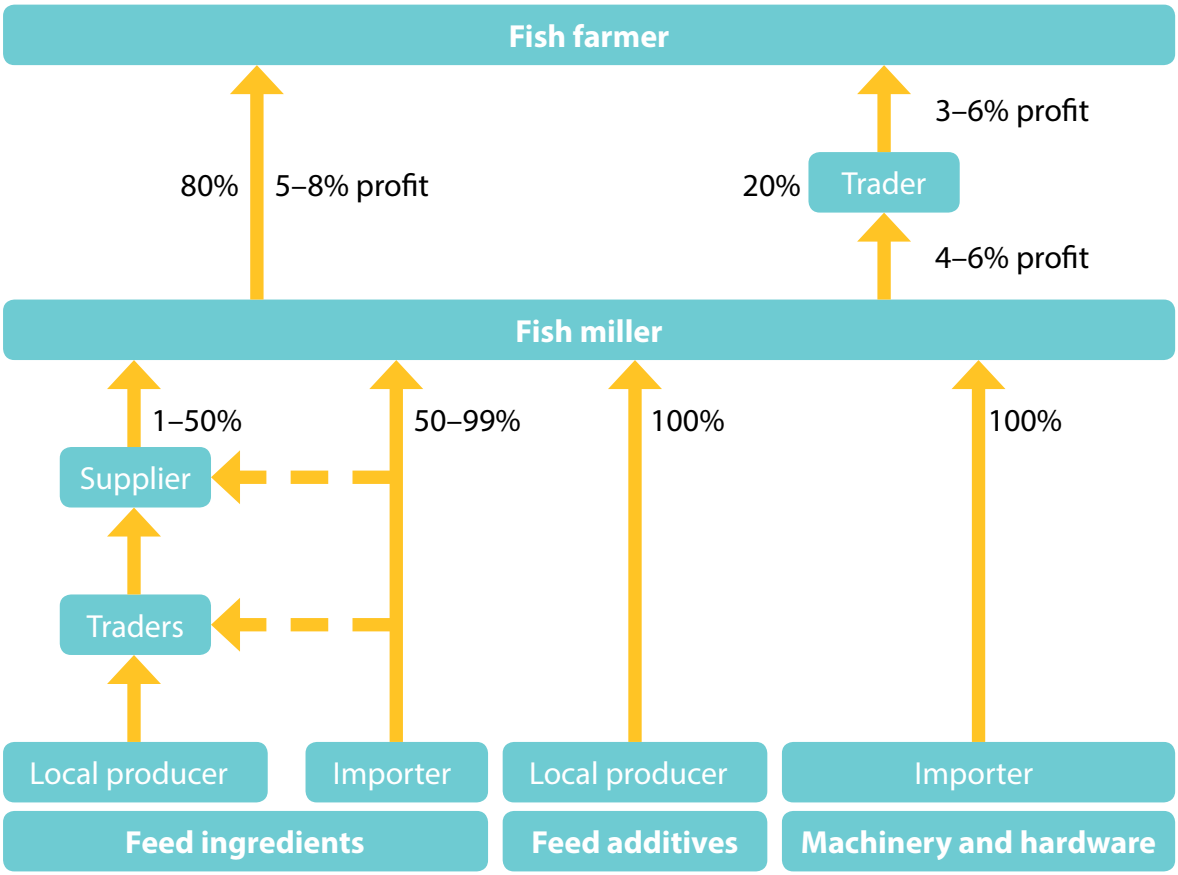


Figure 4: Market share and profitability in the fish feed value chain

Operational data	Public sector	Private sector
Number of mills interviewed	8	17
Average annual production (t/mill)	10,800	13,400
Average % of actual production vs. production capacity	53	79
Average % of extruded feed of total feed produced	0	20
Average sale price of 25% CP pelleted feed (US$/t)	510	550
Average sale price of 25% CP extruded feed (US$/t)	–	665
Average sale price of 30% CP extruded feed (US$/t)	–	708
Average profit margin (%) for 25% CP feed	4.5	7.0
Average number of jobs (FTE) per mill	90.3	29.2
Average number of temporary jobs/mill	5.75	8.9
Average FTE per 1000 t of feed produced	13.3	3.9
Average % of administration jobs	33.3	17.5
Average % of female jobs	10	3.4
Number of working shifts per day	2–3	1–2
Average % of feed sales directly to fish farmers	30	85
Average % of sales to traders/retailers	70	15
Average profit margin of traders (%)	3–5	3–6

Table 4: Operational data for fish feed production and trading in Egypt in 2012

Machinery and hardware providers were excluded from the mapping exercise because information is difficult to collect as the equipment is imported from a wide range of sources at different times. However, the feed millers' questionnaire contained questions about machinery importation, installation, maintenance and hardware availability. The responses suggest that while capital costs are important, maintenance costs for equipment play a relatively insignificant role in overall operating costs.

Operational data

Operational data collected from field interviews for fish feed production and trading in Egypt in 2012 are summarized in Table 4.

Benchmarking

Table 5 contains benchmarking information on feed prices in other African countries. This shows that Egyptian fish feed prices are lower than in most other countries on the continent. However, it is worth noting that Egyptian aquaculture represents around two-thirds of African aquaculture production, so it would be expected to benefit from significant economies of scale.

Legal, policy and institutional environment

Egypt adopted Ministerial Resolution 1498 (1996) (amended by Resolution 1056 (1999) and Resolution 1057) regulating animal feed, feed production, circulation and control and technical permission required for importing feeds, feed ingredients and feed additives. These resolutions include:

- the specifications of feed ingredients;
- the specifications of processed feed, feed packages, labels (containing the type of feed and its ingredients, factory information and net weight of the package);
- issuing technical permission required for importing feeds, feed ingredients and feed additives;
- information/data that should be recorded in the factory and provided to the authorized bodies when needed;
- regulating quality control and inspection of feed factories, manufacturing environments and feed/ingredient selling centers and shops;
- specification of penalties for violating the provisions of the resolution.

	Cultured species	Feed type	Protein content (%)	Price (US$/t)
Egypt[1]	Tilapia/freshwater fish	Pressed	25	550
		Extruded	25	665
		Extruded	30	708
RSA[2]	Tilapia	Extruded	30	720
RSA (2013)[3]	Tilapia	Extruded	30	780
	Tilapia	Extruded	32–35	860–960
	Tilapia	Extruded	40	1038
Ghana[4]	Farmed fish	Extruded	42	1250–1500
Ghana[4]	Farmed fish	Extruded	28–30	770–850
Nigeria Local[4]	Cultured fish	Extruded	NA	1666
Nigeria Imported[5]	Cultured fish	Extruded	NA	2420
Uganda (2010)[4]	Tilapia/catfish/carp	Extruded	30	590
	Tilapia/catfish/carp		35	727

[1]Current study; [2]LT Morshuizen (Personal communication, 2014); [3]L de Wet (Personal communication, 2014); [4]Cocker (2014), [5]GAIN (2011).

Table 5: Fish feed prices in some African countries

However, there is no specific legislation or provisions on fish feed manufacturing in Egypt. Until appropriate legislation is issued, Resolutions 1498 (1996), 1056 and 1057 (1999) should be adopted. These resolutions contain sufficient provisions and articles that can be applied for regulation and quality control inspection of aquaculture feeds.

Fish feed raw materials

Locally produced raw materials

The main protein sources used for fish feed production in Egypt are soybean meal (included at 20–40%) and fish meal (3–22%). Other protein sources such as cottonseed meal (CSM), meat and bone meal and poultry by-product meal are occasionally included at much lower levels. Major dietary energy sources are generally included at the following levels: yellow corn (10–35%), wheat bran (20–30%), rice bran (10–25%) and vegetable oils (1–5%). The inclusion levels of these ingredients depend on the protein and energy contents of the feed, the availability and prices of the ingredients and fish species and sizes. Egyptian production levels of major feed ingredients currently used for animal feed and aquaculture feed production are presented in Table 6. However, they do not meet local demand. In addition, the production of some oil seeds (such as linseed, cottonseed and soybean) has been decreasing since 2004.

Item	2008	2009	2010	2011	2012
Cereals					
Barley	149	148	117	122	102
Maize	7,401	7,686	7,041	6,876	7,000
Rice bran*	507	386	310	397	455
Rye	69	98	84	95	90
Sorghum	867	781	702	839	900
Wheat	7,977	8,523	7,177	8,407	8,796
Wheat bran**	2,446	2,647	2,666	2,731	2,970
Oilseeds					
Cottonseed	193	145	187	218	170
Sesame seed	37	51	46	44	45
Soybean	29	22	43	30	32
Sunflower	21	41	39	19	25
Oils					
Cottonseed oil	36	23	23	29	28
Linseed oil	8	6	5	7	8
Soybean oil	219	232	274	308	305
Sunflower oil	6	9	18	25	33

* calculated based on 7% rice bran in unmilled rice grains;
**calculated based on 15% wheat bran in unmilled wheat grains. Between 8.3 and 10.6 million t of wheat grains were imported annually in 2008–2011, and included in wheat bran production.
Source: FAO (2013).

Table 6: Production of the major food/feed ingredients (thousand t) in Egypt between 2008 and 2012

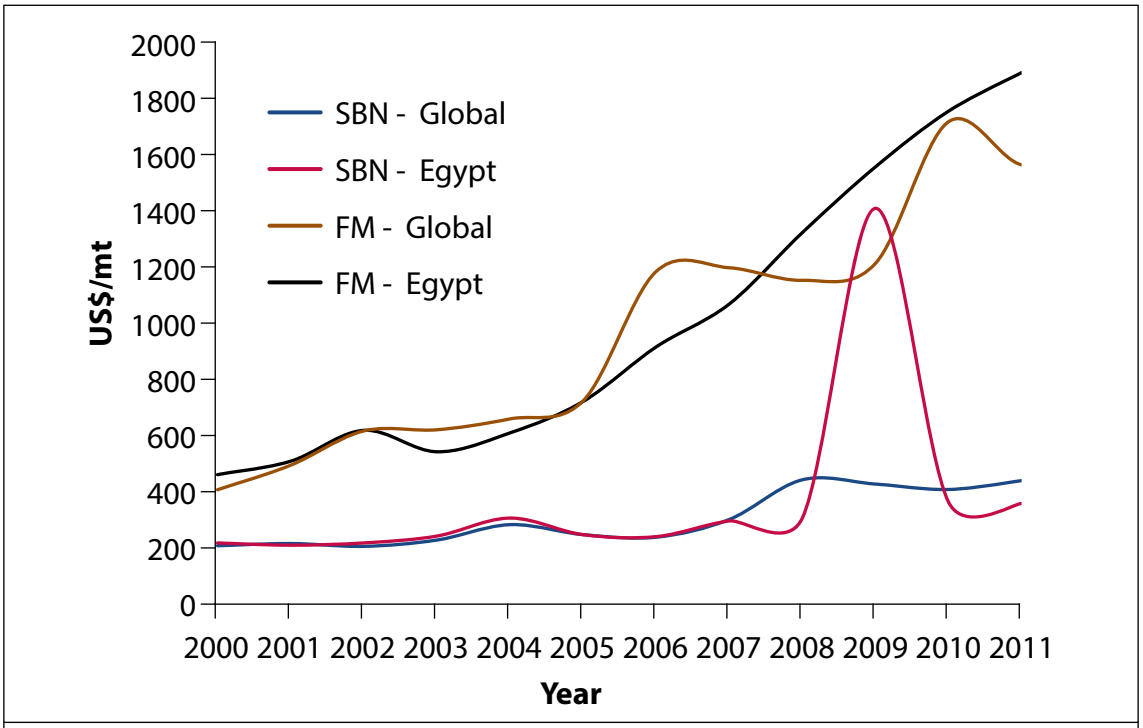
Imported raw materials

It has been estimated that between 54% and 99% of feed ingredients used in aquaculture feed production in Egypt are imported (Tacon et al. 2012; FAO 2013). As a result, the prices of feed ingredients and processed feeds have increased substantially in recent years (Table 7). For example, between 2002 and 2011, the quantities of the major imported feed ingredients increased from 12 million t to over 19 million t, a 65 % increase in imports. In 2011, 99% of soybean cake, 97% of soybean seeds, 89% of sunflower oil, 67% of sunflower cake, 53% wheat and 50% of maize consumed in Egypt were imported. Also the unit prices of these ingredients in Egypt have increased sharply; by 280% for soybean seeds, 206% for soybean oil, 170% for sunflower oil, 147% of maize and 123% for wheat over the period 2002 to 2011. As a result, the prices of processed fish feeds have also increased significantly over the same period.

Global prices of feed commodities have increased significantly during recent years. Figure 5 shows trends in global prices and Egyptian prices of fish meal and soybean during 2000 to 2011. This demonstrates the extent to which feed ingredient prices have increased. It should be emphasized, however, that these prices vary considerably among producers, exporters and importers. For, example, Egypt imports 40–44% crude protein (CP) soybean meal (SBM), supposedly at lower prices than 48% CP soybean meal. Similarly, the protein content of fish meals (FM) range from 60 to more than 70%, leading to wide variation in its prices. The sharp increase in SBM price in Egypt in 2009 was due to the limited amounts imported, leading to severe shortages in the market supply accompanied by high demand.

Ingredient	Quantity (Q) & Price (P)	2005	2006	2007	2008	2009	2010	2011
Wheat	Q (1000 t)	5,688	8,004	8,242	8,328	9,121	10,594	9,800
	P (US$/t)	163	171	262	296	282	245	326
Wheat bran	Q (1000 t)	80	75	65	65	37	45	218
	P (US$/t)	128	150	159	204	577	240	277
Maize	Q (1000 t)	5,095	3,769	5,263	3,980	5,416	6,170	7,048
	P (US$/t)	137	145	205	260	175	206	309
Soybean seed	Q (1000 t)	574	573	1,136	1,192	549	1,752	1,116
	P (US$/t)	378	285	376	378	1204	446	839
Soybean cake	Q (1000 t)	582	301	292	166	76	457	988
	P (US$/t)	243	236	291	301	1,385	357	352
Sunflower cake	Q (1000 t)	58	31	46	30	13	49	51
	P (US$/t)	146	263	251	250	655	173	383
Gluten feed & meal	Q (1000 t)	56	519	172	129	131	158	241
	P (US$/t)	406	456	472	502	717	639	547
Sunflower oil	Q (1000 t)	116	127	151	214	124	404	263
	P (US$/t)	675	620	740	1,343	1,172	923	1,833
Soybean oil	Q (1000 t)	88	45	96	229	38	312	350
	P (US$/t)	566	542	728	1,950	1,830	958	1,523
Meat meal	Q (1000 t)	90	84	87	62	8	3	0.5
	P (US$/t)	335	359	340	391	675	783	840
Fish meal	Q (1000 t)	17.2	28	28	28	28	28	28
	P (US$/t)	709	900	1,050	1,300	1,530	1,725	1,860
Source: FAO (2013)								

Table 7: Imported quantities (Q) and prices (P) of feed ingredients in Egypt during 2005–2011



Source: FAO (2013); Nordahl (2011); USDA/FAS (2012).

Figure 5: Prices of fish meal (FM) and soybean (SBM) in Egypt during 2000-2011 compared with global prices

Feed raw material imports are carried out mainly by the private sector, with a few large importers monopolizing the market by controlling the supply and prices. All fish feed millers interviewed, particularly large-scale producers, buy their ingredients directly from those importers. Various local suppliers and traders also deliver ingredients to small feed producers. However, the research team failed to get sufficient information on the amounts of fish feed ingredients sold by local traders/suppliers, because they all sell feed ingredients to fish feed millers and other animal feed producers (i.e. poultry and livestock feeds). They claimed that they do not have separate records of the amounts sold for fish feed production.

Feed additives

Feed additives, vitamins and mineral premixes are locally produced, mainly by pharmaceutical companies and feed additives companies. Fish feed millers buy their feed additives either directly from these two sources or from additives suppliers/retailers. Just 27% of the private sector millers who were interviewed reported that they had premixes/additives production lines in their mills. They generally buy the ingredients separately (in bulk) from local suppliers and formulate their own additives. The prices of feed additives vary significantly depending on the ingredients contained in the additive.

In the public sector, the feed millers interviewed purchase additives from local suppliers through holding companies. Two millers informed the research team that they incorporate additives only upon farmers' request. This generally leads to higher feed prices.

Fish feed production

Fish feeds in Egypt are produced by public-sector or state-owned holding companies and by the private sector. There is no official data source on current fish feed production and the number of feed mills. However, the number of fish feed mills was estimated at 31 in 2009, 11 from the government/public sector and 20 owned by the private sector, with a production capacity of about 420,000 t/year (El-Sayed 2013). Based on current research, this was an underestimate as the number of feed mills and their annual production capacity are much higher.

Government/public sector mills

There are currently nine government/public sector mills producing fish feeds in Egypt. Two mills are owned by the GAFRD (Figure 6), a division of the Ministry of Agriculture and Land Reclamation (MALR) and seven are owned by the Egyptian Holding Company for Food Industries (EHCFI). Three of the EHCFI mills are owned by the Oils and Soaps Company and four mills are owned by the Rice Milling Company. Although only eight mills (out of nine) were interviewed, the total production of all the mills was recorded. According to the present study, the nine mills operated by state-owned holding companies produced about 100,000 t in 2012. All the feed produced was in the form of conventionally pelleted (sinking) feeds. Most was formulated to contain 25% crude protein (CP). Around 3–5% of this amount contained 17–18% CP, produced upon farmer's request. Most of governmental/public sector mills work 2 to 3 shifts per day, depending on market demand. Yet, the average production of these mills in 2012 represented only 53% of their total annual production capacity.

Private mills

There are at least 50 registered private sector feed mills in the country (Figures 7 and 8). During this study, the research team identified about 20 mills in Kafr El-Sheikh alone, with 15 mills in the industrial zone in Balteem. The research team was told that there are a similar number of mills in Dakahlia Governorate, especially in Asafra Industrial Zone in Manzala, Dakahlia (S. Desouky, owner of fish feed mill; Manzala Dakahlia, personal communication, 2013). These manufacturing plants produce both conventionally pelleted and extruded feeds for various marine and freshwater fish species.

Figure 6: Government-owned conventional pellet feed mill at Barsiq, Behaira. Courtesy: A.-F.M. El-Sayed

Figure 7: Privately-owned feed mills. Courtesy: A.-F.M. El-Sayed

Figure 8: Fish feed extrusion mill. Courtesy: H.A. Mansour, Zoocontrol Aquafeed Mill

It has also been reported that there are about 50 small-scale pelletizing units, each with an annual production capacity of 3000 to 4000 t of fish feed, representing total annual production of 120,000 to 240,000 t (El-Naggar et al. 2011; cited in Macfadyen et al. 2011). The majority of these pelletizing units are not registered and their production is generally not recorded. However, current estimates suggest that the number of non-registered fish feed mills has increased dramatically during the past few years, to over 200 units. These milling units are generally locally made, use simple technologies and are usually not equipped with air driers. They also offer a service of pelletizing farmers' feed ingredients at a cost of about EGP 100–150 per t (El-Naggar et al. 2011).

In addition, many farmers currently buy their own ingredients, prepare their feed formulae and rent the feed mill to manufacture the feed (A.-F.M. El-Sayed, Alexandria; H. Eshra, fish feed miller and fish farmer, Edku, Behaira 2013). Those farmers generally do not report the amounts of feed they produce. It should be emphasized, however, that many of those rented feed mills do not have specific lines for fish feed production. Instead, they use the same production lines that are used for producing poultry and rabbit feeds. This approach leads to substantial reduction in feed costs for farmers. One farmer in Edku (Behaira Governorate) said that he saves about 10–15% (about US$ 50–70) per ton of feed by adopting this approach.

The amount of feeds produced by the private sector mills in 2012 represented 79% of their total production capacity. The majority of these mills (68%) work one shift (8 hours) per day, for 6–7 months (May–October/November), 27% work two shifts, while only 5% work three shifts.

It is clear from the above findings that the amount of fish feed produced by the private sector feed mills in Egypt is higher than the previous studies suggest. The 17 mills interviewed produced 215,000 ton in 2012, or about 13,400 t/mill/year on average. The total volume of feed produced by registered mills (about 50 mills) can be estimated at about 670,000 t. If the amounts produced by non-registered mills (about 120,000–240,000 t) and those produced by the farmers are considered, it would be safe to suggest that the total production of fish feeds from private sector feed mills exceeds 800,000 t and may reach 1 million t per year.

About 80–85% of this production was in the form of conventionally pelleted feed while the remaining 15–20% was extruded (floating) feeds. Only a few feed mills (5 to 10 mills) produce extruded feeds as this requires specialized production lines. The proportion of extruded feed produced by individual companies varied between 20% and 80% of their 2012 production.

Over 95% of the feeds produced by the private sector were formulated to contain 25% crude protein (CP), while the remaining 5% contained either 30, 32 or 35% CP, and are generally produced at the farmer's request. In addition, a few tons of feed containing >40% CP are also produced at farmers' request and used for larval feeding or marine fish feeding. Most (over 90%) of the feed producers said they do not produce larval feeds because it is such a small market, as very small amounts of feed are required during early growth stages. Processed grow-out feeds are commonly ground into powder-like meals and used for feeding fish larvae.

Investment in fish feed manufacturing

Establishing a commercial fish feed mill is costly and complicated. It requires large amounts of capital for initial infrastructure and machinery setup and subsequent running costs for operating the mill. Skilled labor and professional management are necessary to establish and run commercial fish feed enterprises.

Unfortunately, it was difficult for the research team to obtain sufficient information on the investment in fish feed manufacturing, particularly capital investment, from the interviewed feed millers. Only two feed manufacturers provided full details on the capital and running costs of their mills (Table 8). The rest of the producers provided scatered information on their operational expenses, and only as a percentage of total running costs.

	Small-scale mill		Medium-scale mill	
	Cost (US$)*	**% of total running costs**	**Cost (US$)***	**% of total running costs**
Running costs				
Feed ingredients	1,415,100	94.13	2,751,572.0	87.90
Premixes and additives	23,585.0	1.57	235,849.0	7.53
Transportation and storage	13,364.8	0.89	62,893.0	2.00
Electricity and fuel	13,993.7	0.93	31,446.5	1.00
Labor and management	29,874.2	1.99	24,371.0	0.78
Hardware and maintenance	6,289.3	0.40	7861.6	0.25
Other costs	1,415.1	0.09	16,195.9	0.52
Total running costs	1,503,322.1	100.0	3,130,189.0	100.0
Capital costs				
Depreciation	25,723.3		257,300	1.1
Taxes	15,000		16,600	1.2
Total fixed costs	35,723.3		273,900	1.3
Total costs	1,544,045.5		3,404,089	1.4
Total revenue	1,650,094.0		3,609,183	1.5
Net profit	106,048.5		205,094.0	1.6
% of profit to total costs	6.9%		6.02%	1.7
Note: 1 US$= EGP 6.36 in 2012.				

Table 8: Operational and capital costs of small- and medium-scale feed mills in 2012

Employment

Government/public sector feed mills

The employment rate in fish feed production varies significantly between public and private sector mills. In the governmental/public sector mills, the number of permanent jobs ranges from 36 to 106 people per mill, with an average of 90.3 jobs/mill. Female jobs represent 10% of total permanent employment. In 2012, the average number of temporary jobs was 5.75 jobs/mill. Gharbia Rice Milling Company at Shabsheer El-Hessa, which produced 30,000 t in 2012, is an exception; it employs 3,700 temporary workers during the production season (May–October).

The ratio of administrative jobs to production-related jobs is very high in the public sector, ranging from 13 to 60% with an average of 33.3% of total permanent jobs. Most interviewees acknowledged that employment in administrative and technical divisions is higher than needed. Direct employment in public sector mills in 2012 was 13.3 FTE for every 1000 t of feed produced.

The workers get their salaries paid throughout the whole year, although the production season extends for only 6–8 months of the year to match production from fish farms during the growing season (April–October). As a result, the profit margins of public sector feed mills are relatively low (US$26/t).

Private sector feed mills

The employment rate in the private sector fish feed mills is much lower than in the public sector. The number ranges from 3 to 110 persons mill, with an average of 29.2 jobs/mill. Female jobs represent 3.4% of total permanent employment. In fact, in the 17 private mills interviewed, only 3 mills acknowledged that they have permanent female jobs (one mill has 10 women, one has 3 and one has only 1 woman).

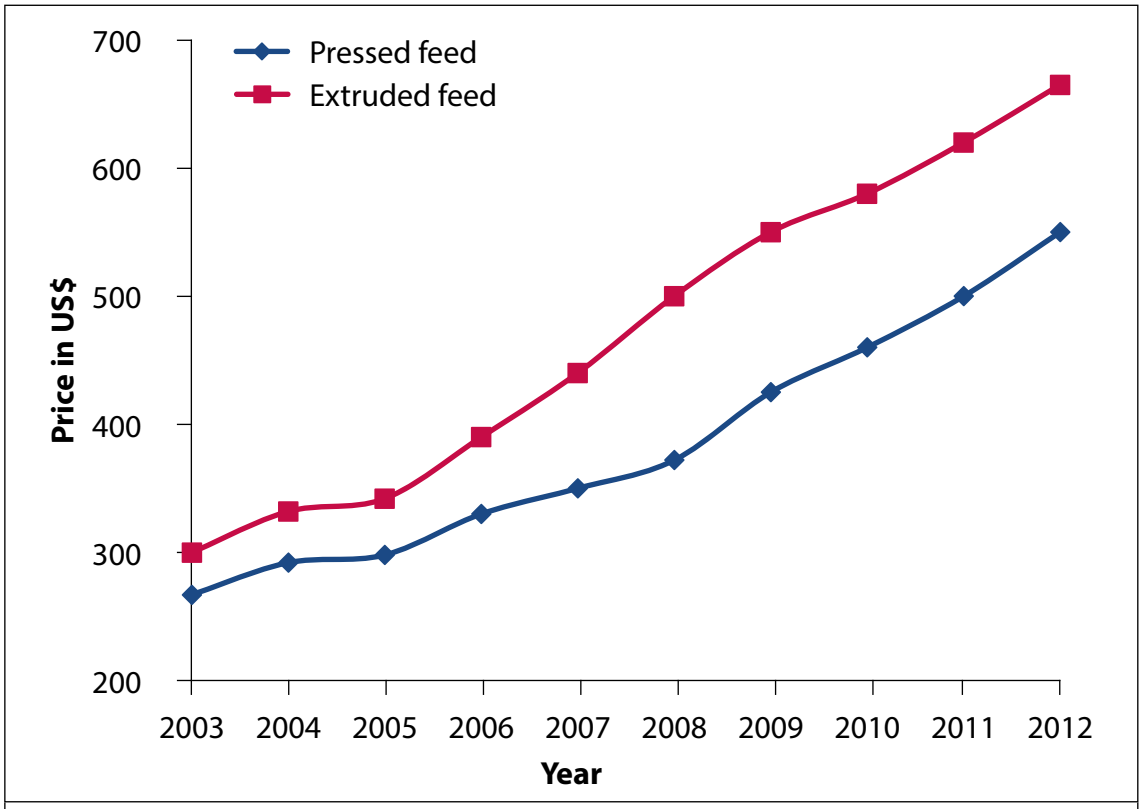
In 2012, the average number of temporary jobs was 8.9 jobs/mill. The proportion of administrative jobs in the private sector in 2012 ranged from 1.5% to 33% with an average of 17.5% of total permanent jobs, almost half of the proportion of administrative jobs in public sector mills. Direct employment in private sector feed mills is only 3.9 FTE for every 1000 t of fish feeds produced and much lower than the equivalent figure of 13.3 FTE/1000 t in public sector mills. However, profit margins in private sector feed mills (average US$ 38/t) tend to be higher than those in public sector mills (average US$ 26/t).

Feed traders, handling and marketing

Market share

About 85% of fish feed producers in the private sector sell their products directly to farmers, and only 15% sell to traders or retailers. Traders are sometimes also fish farmers, but they sell feed as an additional source of income. Traders and retailers sell the feeds to farmers with a price increase of about 2–5% (average 3.7%). In many cases, small-scale fish farmers purchase feed from producers on credit, or pay 50% of the price in cash and pay the rest on credit. In such cases, the cost of the feed can be paid after fish harvesting and selling. However, the prices increase by 3–6%. Under these conditions, the farmers risk receiving poor quality feed, but they have little bargaining power and don't complain or object. Feed suppliers sometimes require payment for the feed as soon as possible, regardless of when it is the best time to market fish - which means farmers are forced to harvest and sell their fish during the peak fish sales time at the end of the year, when market prices are lowest.

The situation is different in state-owned/public sector feed mills where about 70% of produced feeds are sold to traders, and only 30% are sold to the farmers directly. This is because a credit-based system is very difficult to apply in the public sector. The mills generally ask for specific guarantees such as fixed assets, movable assets or savings certificates, but most small-scale farmers (under 10 ha of pond area) cannot provide these guarantees, making feed marketing one of the most serious problems facing public-sector fish feed mills.



Source: El-Saved (2007) and the present study

Figure 9: Prices of fish feeds (25% cp) in Egypt during 2003-2012

Prices for conventionally pelleted tilapia feeds in Egypt have more than doubled during the past decade, increasing from US$ 260/t (25% CP) in 2003 to US$ 510/t in the public sector and US$ 550/t in the private sector in 2012. Similarly, prices for extruded feeds have more than doubled, from US$ 300/t in 2003 to US$ 665/t for 25% CP feed and to US$ 708/t for 30% CP feed in 2012. This is due to sharp increases in feed ingredient prices, especially for imported ingredients such as fish meal, soybean meal, corn, wheat bran and oils. The higher price for extruded feeds compared to conventionally pelleted feeds is due to the high costs of installing and operating extruders (Figure 9).

Feed packaging

Most commercial fish feeds produced in Egypt are packed in 25 kg polypropylene bags (Figure 10) which are closed mechanically with string or are heat sealed. Bagged feeds are generally only stored for relatively short periods (maximum of 1–2 weeks) in shaded, well-aerated. However, some factories (especially public sector mills) lack appropriate storage facilities for ingredients and finished feeds.

Figure 10: Packaging of fish feeds. Courtesy: A.-F.M. El-Sayed

Transportation

Large-scale feed producers generally use their vehicles for feed transportation, especially when a large amount is being sold. In large mills, feed is loaded on the trucks automatically (Figure 11). In small- and medium-scale mills, feeds are loaded manually. Small farmers, who generally buy small amounts of feed, use their own trucks or rented trucks. Sometimes farmers from the same area will rent a truck together if they are buying from the same mill.

A margin of 1–2% is added to the feed price to cover delivery costs, depending on the distance and the amount. Many farmers and feed producers indicated that the cost of feed transport has increased, particularly during the past two years, due to increases in fuel prices. More importantly, the unstable political and economic situation in Egypt has made any transport activity somewhat risky due to insecurity on the roads.

Figure 11: Automatic loading of fish feeds on a large truck. Courtesy: A.-F.M El-Sayed

Storage
One of the most serious challenges facing public sector feed mills and small-scale privately owned mills in Egypt is poor handling and storage of ingredients and processed feeds. They are often stored outdoors, on the ground, with poor shade or protection from the elements, leading to deterioration in the quality of both raw materials and feeds (Figure 12). In contrast, many larger-scale private feed mills have excellent handling, storage and transportation facilities, and comply with the Code of Practice for Good Animal Feeding (FAO 1998). Although the feed prices from these mills may be higher than those from the government-run mills, many fish farmers prefer to buy from them.

Fish farmers

Most of the fish farmers interviewed acknowledged that fish feed is the most important component of their farming practices, comprising 75–95% of total operating costs. This makes escalating feed prices a serious problem, especially for small-scale farmers.

Lack of access to credit has been a major constraint facing Egyptian fish farmers for many years (Zwirn 2002; El-Gayar 2003; El-Naggar et al. 2008). Both state-owned banks and private banks are reluctant to finance aquaculture enterprises, especially small-scale businesses. No insurance system is currently available to fish farmers in Egypt. Therefore, only large-scale aquaculture enterprises can obtain credit from the formal financial sector.

As a result, many small-scale fish farmers purchase processed feeds, feed ingredients, feed additives, etc., from the producers or traders on credit. Only 31% of interviewed farmers paid for their feed in cash, whereas 44% said they purchased on credit. A further 25% said they use a partial payment system, where they pay about 50% of the price in cash and the rest after harvesting and selling their fish crop. Many of the interviewed farmers reported that they sometimes receive poor quality feed (i.e. high dust or moisture levels and low pellet durability). This has been supported by the proximate analyses of random samples of different fish feed used by different farmers in different geographical areas (Section 4.1). However, 79% of farmers do not run any chemical analysis of the feed they purchase, mainly due to the high cost of analysis, and rely instead on the information provided by the manufacturer.

About 60% of semi-intensive fish farmers said they use pond fertilization in addition to supplementary feeding. Both organic fertilizers (poultry manure) and inorganic fertilizers, (urea, superphosphate (SP) and triple superphosphate (TSP)), are widely used. The farmers reported this as leading to significant decreases in running costs and improved feed utilization efficiency due to the contribution of natural food to pond production. The normal practice is to fertilize ponds before and just after stocking with fish. As the fish grow, water exchange increases, making pond fertilization less important.

Figure 12: Storage and handling of fish feeds. Left: Poor storage (Courtesy A.-F.M. El-Sayed); Right: Excellent storage Courtesy: H.A. Mansour, Zoocontrol Aquafeed Mill

Quality control inspection

Ninety percent of public sector mills reported that they regularly conduct proximate analysis of the feed ingredients and compound feeds in the laboratories of the Ministry of Agriculture and Land Reclamation (MALR). Only one mill (Behaira Rice Milling Co. in Dalangat) runs proximate analysis at its own lab.

In the private sector, 45% of feed producers acknowledged they run proximate analyses in private laboratories/public laboratories (universities, MALR and private labs). Just 35% of the interviewed producers have their own proximate analysis facilities. The remaining 20% do not run any analysis. In addition, 60% of the producers claimed that they do not receive any extension services or quality control inspection from any governmental authority or non-governmental organization (NGO).

The remaining 40% of millers indicated they receive governmental quality control inspection regularly or occasionally.

Nonetheless, the appearance, texture and proximate analysis (Table 9) of feed samples collected by the research team indicated that the quality of the feed produced by some private mills was extremely bad, confirming that those mills lack basic quality control inspection (Figures 13 and 14). Only 43% of the analyzed samples matched the labels. The protein contents of the rest of the 25% CP feed samples were 20.5–23.2% which are 9–18% lower than the values recorded on the labels. The lipid content of one sample was very low (3%), while the fiber content of some feeds was high (>15%). Similarly, the moisture content of some tested feeds were also relatively high (>12%).

Mill code	Crude protein on label (%)	Proximate analysis (present study):				
		protein	lipid	ash	moisture	fiber
ZCN	32	31.4	6.5	10	12.2	7.6
FNG	30	29.2	5.9	9.3	10.2	11.2
EKH	25	24.2	4.6	6.5	5.0	9.8
ASH	25	20.5	3.0	8.0	8.0	15.5
SAD	25	23.0	4.1	7.8	6.5	10.5
HEG	25	22.0	5.0	8.2	10.0	11.3
HDX	25	24.7	5.1	7.0	9.0	8.0
GAB	25	23.8	5.8	7.3	10.2	10.2
HRM	25	21.2	3.3	10.1	12.6	12.3
Source: this study						

Table 9: Proximate analysis of Egyptian commercial fish feeds

High moisture levels (>12%) combined with high temperatures (>25 ^{0}C) favor the growth of molds which can produce mycotoxins such as aflatoxins, with damaging impacts on farmed fish. Mycotoxins have been shown to cause poor growth, impaired immune response, disease, high mortality, and declines in fish quality (Santacroce et al. 2008; Manning 2010). Mycotoxins could also be present in the feed raw materials. Contamination of Egyptian feed ingredients such as maize, rice germ, rice bran, wheat bran, and cottonseed cake with aflatoxins has been previously recorded (Abdelhamid 1990). Poor storage and transportation of feed ingredients (Figure 13) and processed feeds, could lead to serious deterioration of the quality of these feed sources.

Egypt has a standard regulating mycotoxins in human food (Egyptian Standard UDC 615.91. Maximum Limits for Mycotoxin. In Foods, Part I: Aflatoxin). However, no such standard is applied to animal feeds.

Figure 13: Poor storage and transportation of feed ingredients. Courtesy, A.-F.M. El-Sayed

Figure 14: Compressed fish feeds produced by the private sector. Left: good quality feed. Note the size homogeneity of the pellets and the well-ground ingredients. Right: bad quality feeds. Note the variation in pellet sizes with some very large pellets (over 1 cm long). Note also the poor grinding of the ingredients with unground large pieces of yellow corn. Courtesy: A.-F.M. El-Sayed.

Financial services

As stated earlier, no insurance system is currently available to fish farmers in Egypt, despite the recent emergence of a global aquaculture insurance market. Consequently, fish farmers, especially small farmers, have less access to credit and financial support. This situation makes government and private sector banks reluctant to finance aquaculture enterprises. As a result, small farmers purchase farming inputs, including processed feeds, feed ingredients and feed additives from producers or traders on credit, at higher prices and are more at risk of being supplied with poor quality feed.

Extension services and capacity building

Over 80% of fish feed millers, technicians and engineers said they have received no capacity-building training by government or private sector organizations, although the majority of them claimed that they need such training to improve their skills, and to learn about recent fish feed production and management technologies. In addition, all of the farmers interviewed said that they do not receive any training, capacity building or government extension assistance on aquaculture, fish nutrition, or feeding management. Most of the farmers lack basic knowledge about feed management and feeding practices so they often use feed incorrectly. It is thus no surprise that the feed conversion ration (FCR) of most semi-intensive pond farms fed with 25% CP conventionally pelleted feed was greater than 2:1 whereas it should have been much lower (1–1.5:1).

Role of producer organizations

There are 11 aquaculture cooperatives in Egypt, in the major production governorates and affiliated to the national apex body, the Union of Aquatic Cooperatives which includes both aquaculture and fisheries coops. With the exception of Fayoum Fish Farmers Association (FFFA) these associations play no role in providing fish feed services to fish farmers. In Fayoum, the FFFA buys good quality feed in bulk for its members, through an annual tender process and with price savings on bulk orders. It also operates a credit system where the farmers pay in advance for only 50% of their annual feed costs and the rest is paid on credit, or through monthly payments, without increasing the price. This means that farmers are not forced to obtain credit from feed traders, and are at less risk of being provided with poor quality feed. FFFA also buys other production inputs such as seeds, additives, drugs, premixes and water quality analysis equipment in bulk and sells them to the farmers at promotional prices; very often on credit (M. Gouda, chairman of FFFA, personal communication, 2013).

Critical factors

The following issues were identified as critical factors affecting the performance of the Egyptian aquaculture feed sector:

1. **Dependence on imported feed ingredients**. The prices of feed ingredients have been increasing in global, and consequently in domestic markets, leading to escalating prices for fish feeds, and this trend is set to continue. Furthermore the business is monopolized by a few large importers, who control the supply and price. Many feed producers complained that there are continuous fluctuations in the availability and quality of the ingredients they receive from the importers.

2. **Limited capacity for production of high quality feeds**. Many private and public mills are producing poor quality feeds, mainly due to the use of old technology and/or lack of quality control. Over 80% of Egyptian aquaculture feed is conventionally pelleted. If poorly formulated, processed and applied, the use of these feeds can lead to low feed efficiency and substantial waste. This study found that the average FCR for farmers using these feeds was 2:1, compared to FCRs of 1–1.5:1 for extruded feeds. In addition, feed ingredients and finished feeds are often badly handled and stored at feed mills, especially in state-owned mills and small privately-owned mills, while there is insufficient quality control inspection by government authorities, especially in private feed mills.

3. **Seasonal production cycle**. All feed mills work for only 6 to 7 months per year because demand from farms is seasonal, while permanent employees are paid for the whole year. This reduces the profit margins of mill owners and results in a preference for temporary rather than permanent employment.

4. **Limited opportunities to increase employment**. There appears to be little room to increase job opportunities in the fish feed sector. About 4000–5000 employees and workers are engaged in the industry, most of whom only work for 6 to 7 months per year. Even if demand for feeds continues to increase, there is unused capacity to fill the gap. The situation is worst in public-sector mills where there have been unnecessary increases in administrative employment.

5. **Limited access to credit**. Public fish feed mills find it difficult to market their feeds and sell most of their production to traders/retailers, rather than directly to farmers. This is because a credit-based system is very difficult to apply in the public sector, because most small-scale farmers cannot provide the required guarantees. Most fish farmers also lack access to independent credit or financial support. As a result, they purchase the feeds from producers or traders on credit at higher prices, and are at risk of receiving poor quality feed.

6. **Limited access to training**. Most feed mills and fish farmers do not receive capacity building or other extension services. Without basic training, feed mills cannot make high quality feeds and farmers will use feed inappropriately, leading to feed wastage and poor feed efficiency.

Suggested actions

1. **Reduce dependence on expensive feed ingredients**
   Many feed millers suggested that the government should intervene by applying strict regulations for imports and price controls to break up, or at least reduce, the monopoly that the private sector operators have over the importation of feed ingredients. Some also suggested that the government should import feed ingredients to ensure that the private sector does not control the market. Reduced import tariffs would also be a way of reducing feed ingredient prices. However, it seems unlikely that these actions could be implemented, as they would need to apply across the entire animal feed industry. It may be more realistic

for the authorities to introduce measures to encourage opportunities for local production of feed ingredients. This approach was used successfully in Bangladesh with chicken feeds in the Katalyst project. However, restrictions on land and water availability may limit or constrain the viability of this approach in Egypt.

Alternative feed raw materials could make a useful contribution towards reducing costs but will require further research. Potential candidates include: algal meals, single cell protein, insect protein, animal and fish by-products, food processing by-products, and nutrient-rich forages. However, the large scale of the Egyptian aquaculture industry means that very significant quantities would be required in order to make an impact (10,000 t = 1% of total aquaculture feed raw material requirements).

2. **Improve capacity for production of high quality feeds**
Quality control and inspection procedures should be put in place to improve feed quality. Inspection should include regular testing of feed ingredients and finished feeds, including proximate analysis and testing for contaminants such as mycotoxins. More feed mills should operate their own analytical labs so they can screen ingredients and verify that finished feeds meet expected specifications.

Inspection of feed producers, suppliers and ingredient importers is necessary to ensure that they comply with the international quality control standards, such as Hazard Analysis and Critical Control Points (HACCP) and the Code of Practice for Good Animal Feeding (FAO, 1998).

While extruded feeds are preferred by many fish farmers because they are considered to be more efficient than conventionally pelleted feeds (in feed conversion terms), they are significantly more expensive, as the capital costs of an extrusion processing line is more expensive and has higher operating costs (power requirements and maintenance costs). Feed management is easier with floating pellets than with sinking feeds and this is why extruded feeds are preferred by some fish farmers. Pelleting entails buying high quality ingredients, following best practices in handling and storage of raw materials, grinding the raw materials into small particle sizes, accurate weighing out of ingredients, effective mixing of ingredients and so on. The problem with many conventional pellet mills in Egypt is that they are using old, poorly maintained equipment and not observing best practices throughout their handling, processing and storage lines. The result is poor quality feeds that will have clear impacts on fish growth and the profitability of fish farms.

Many of these deficiencies could be solved through training, whereas others will require investment in new equipment.

3. **Increase employment opportunities in the aquaculture feed sector**
The seasonal nature of aquaculture production systems in Egypt means that there is much higher demand for feeds in summer and autumn than in winter and spring. Although feed mills are operating at full capacity for half of the year, they stand idle at other times, but this does not mean that there is spare capacity. As fish farm production continues to grow, the peak feed requirement and employment opportunities will also grow, for both full-time and seasonal staff.

While it is assumed that many jobs are for youth, the current survey did not generate separate data for this group. However, it did confirm that employment levels of women in this industry are low, probably because of the tough physical environment in feed mills.

There are potential strategies to smooth out feed production through the year, thereby increasing the ratio of permanent to seasonal workers. One option would be to produce more feeds in the off-season, and store finished feeds in temperature controlled stores for sale in the peak season. However, prolonged feed storage is undesirable and is likely to be more expensive than increasing peak capacity of existing feed mills. There may be opportunities to improve the efficiency of feed mills, particularly in inefficient public sector mills, through training and rationalization. There may also be opportunities to extend the feed processing season by supplying export markets. Egyptian

feeds appear to be competitive in terms of international feed prices. As aquaculture is set to grow in other parts of Africa, Egyptian feed mills could target new markets.

A more realistic option for increasing employment in the fish feed sector would be to focus efforts on local raw material production. This would create significant levels of employment at the base of the supply chain. However, this would have to be weighed against the increased demand for irrigation water that would be needed for production of feed raw materials such as soybean. In a water deficient country such as Egypt, it may be more efficient to continue to import raw materials.

4. **Improve access to credit**
   Most Egyptian aquaculture businesses have a seasonal production pattern, requiring significant investments in feeds over a six to eight month growing period before fish can be sold at the end of the year. The majority of fish farms are operated in leased ponds (which cannot be used as collateral) and many (perhaps 60%) are also unlicensed, making it difficult for them to borrow money from formal sources such as banks to fund feed purchases. This forces them to depend on credit from feed mills, feed traders (in the case of farmers buying from government-owned mills) and sometimes wholesalers who will buy their fish at harvest.

   This is far from ideal, but it is these informal credit relationships that have allowed Egypt's aquaculture industry to thrive and introduction of a more formal credit system would be difficult. Fish farms need to be licensed, they need better tenure over their land (most only have 3-year leases) and/or water and they need to have bankable collateral beyond the stock of fish in their ponds. Commercial banks need to learn about how aquaculture works (e.g. they cannot expect fish farmers to start making loan repayments immediately because of the seasonal nature of the business) and there will be little progress on any of these issues unless fish farmers can organize themselves more effectively to fight their case.

   Nevertheless, Fayoum Fish Farmers Association offers an example of a group of fish farmers who have organized themselves and through bulk purchasing, have negotiated a better credit arrangement with feed suppliers.

5. **Improve access to training**
   Egypt's aquaculture feed sector has expanded rapidly over the last few decades to meet growing demand from aquaculture producers. As this study has shown, there are many new feed mills, with a wide range of quality standards, from internationally recognized feed brands to farm-made feeds. While experienced operators and larger mills usually have in-house support for capacity building, smaller mills will not. Training will be required in: sourcing quality materials, feed formulation, feed processing, equipment maintenance, marketing and business management, in order to produce the high quality feeds expected by the customers. Meanwhile producers need training in feed storage, feeding systems and feed management in order to improve the efficiency of feed use.

6. **Strengthen the legal and policy environment**
   While there are Ministerial Resolutions governing animal feeds, there are significant weaknesses in the legal framework and its enforcement in the aquaculture feed sector. This should include registration and regular inspections of business in the feed production sector as well as setting and enforcing quality standards. This could involve a partnership approach between a quality-focused feed industry organization and the regulatory authorities.

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Appendix 1. Feed manufacturers' questionnaire

General information:

1. Location (Governorate-district-county):

_____

_____

_____

2. Ownership (public-private)

_____

_____

_____

3. Are you the owner of the mill-the manager- both:

_____

_____

_____

4. When did you start business?

_____

_____

_____

5. Do you produce other animal feeds)?

_____

_____

_____

6. If yes; what type of animal feeds do you produce?

_____

_____

_____

7. What is the % of fish feed of total annual feed production?

_____

_____

_____

8. What type of fish feed do you produce (pelleted, extruded, both):

_____

_____

_____

9. In case of producing 'both types', what is the % of each type?

_____

_____

10. Do you have other sources of income in addition to feed manufacturing?

_____

_____

Description of the value chain

11. Production

Production capacity in 2012 (t/yr)				
Real production in 2012 (t/yr)				
Feed produced according to fish growth stage:	% of total production	Pellet size (mm)	% CP	% lipid
1. Larval feeds				
2. Fingerling/juvenile feeds				
3. Fattening feeds				
4. Others				
For what fish species do you produce the feed	The % of feed produced for each species (group)			
Tilapia				
Mullets (which species?)				
Carps (which species?)				
Catfish				
Marine fishes (which species)				
Others (e.g. shrimps, export): Describe				
Number of shifts per day	One shift ( ) Two shifts ( ) Three shifts ( )			
Other comments				

12. Feed additives and premixes

Do have a production line for feed premixes/additives in your production facility?

If yes:

- What additives do you produce (Vitamin and mineral mixes, enzymes, probiotics, etc.),

  _____

- What is the % of additives/premixes produced for fish feed compared to that produced for other animal feeds?

  _____

- What is the average price in 2012?

  _____

If no,

- Where do you get your additives/premixes from? (mention the source if possible):

  _____

- What is the change in the prices of feed additives in 2012 compared to previous years? (Increased- decreased- stable).

  _____

13. Employment

Type of people employed	Total employment	Number of employees from same governorate/ county	Number of employees from other governorates/ counties	Estimated total days of employment per year (i.e. number x working days per year
Men-seasonal				
Women-full time				
Women-part-time all year				
Women-seasonal				
Others (Consultants)				

14. What is the % of the following employment:
    a. Administrative jobs _____%
    b. Technical jobs (Technicians, engineers, etc) _____%
    c. Laborers _____%
    d. Others (mention) _____%

15. What proportion of your total yearly earnings/sales revenue come from aquafeed production, and what proportion from other business activities you may have?
    _____% from aquafeed production
    _____% from animal feed production
    _____% from other business activities

16. Which link in the value chain is most important in setting prices for feed? Arrange according to the importance:
    (Feed sources- traders/wholesalers- machinery- fish farmers- other factors)

    _____

    _____

17. How much feed did you produce and sell in 2012 in terms of volume and value, and for what average price?

Type of feed	Production volume (t) in 2012	Average annual price (US$/t) in 2012
Extruded:		
25% CP		
30% CP		
35% CP		
40% CP		
others		
Pressed:		
25% CP		
30% CP		
35% CP		
40% CP		
others		

18. From where do you buy your feed ingredients?
- ( ) Direct importation - ( ) From local market - ( ) Others (mention)

19. From where do you buy your machinery and spare parts?
- ( ) Direct importation - ( ) From local market - ( ) Others (mention)

20. How have fish feed volumes, sales revenue and prices changed compared to previous years?

Type of feed	Annual production volume in t (up, down, stable)	Average annual price in US$/t (up, down, stable)
Extruded:		
25% CP		
30% CP		
35% CP		
40% CP		
others		
Pressed:		
25% CP		
30% CP		
35% CP		
40% CP		
others		

21. What % of the total volume of your sales do you sell to:
- Fish farmers directly _____%
- Fish feed traders/wholesalers _____%
- Fish feed retailers _____%
- Fish farmers' cooperatives _____%
- Other (mention)_____%

22. What are the main sources of finance used in your fish feed business (tick and obtain % if possible)
( ) self-finance _____
( ) Cooperatives _____
( ) Investors (local/regional/international) _____
( ) Formal bank sources _____
( ) Other sources (describe): _____

23. What are the operating costs?

Cost item	% of total operating costs in 2012	Change in the cost over the years (up, down, stable)
Feed inputs (ingredients and raw materials)		
Premixes and additives		
Power, fuel, electricity, water		
Maintenance and spare parts		
Labor and management (technical and administrative)		
Storage and transport		
Sales commission		
Feed analyses, quality inspection and monitoring		
Training and capacity building		
Other (specify)		

24. What are the fixed/investment costs?

Cost item	% of total fixed costs 2012	Changes in the cost over the years (up, down, stable)
Financial/interest charges		
Machinery/Buildings/other infrastructure (depreciation charges)		
Licenses/taxes/other government charges		
Others (specify)		

25. After paying the operating costs, how much profit do you make on overage from selling fish feeds (US$/t)

_____

_____

26. What are the major critical factors impacting on the inputs of aquafeed industry

Input being used	Problem experienced or expected	Why does this problem occur?	5.2.11 What do you think this problem could be solved	5.2.12 Feed raw materials
Labor				
Machinery (spare parts, availability, etc.)				
Electricity, fuel, power				
Storage				
Transport/delivery				
Taxes				
Governmental bureaucracy				
Others				

Other questions

27. Do you export any part of your production to foreign countries? ( ) yes ( ) No
If yes:
- What is the % of exported feeds of total annual feed production?: _____
- To which countries do you export your feeds, and for which fish species?: _____

28. Do formulate your feed using least-cost computer programs, or using preset formulae?

_____

_____

29. Do you receive any governmental subsidies? If yes, describe

_____

_____

30. Do you receive any other governmental service (such as extension service or quality control inspection)? If yes, describe the type of service, and how often.

_____

_____

31. Is there any specific union, cooperative, NGO represent, or speak for, fish feed manufacturers? If yes, please describe

_____

_____

32. Do you have any training and capacity building programs for your workers? If yeas, describe these programs _____

_____

33. Do you need any specific capacity building programs? Specify.

_____

_____

34. Do you perform regular proximate analyses of your ingredients and processed feeds? If yes, how often? Do you have your own lab or use external labs?

_____

_____

35. What is the maximum shelf life of the feed inside the factory (i.e. how fast is the feed sold after produced?).

_____

_____

36. Do you use your vehicles to transport the feed to farmers/wholesalers?

_____

_____

37. What storage facilities do you have (both for raw materials and processed feeds)?

_____

_____

38. What type of problems do you have in the storage of feed ingredients and produced feed?

_____

_____

39. Is there any current or future expansion, innovation, development in your mill for improving production capacity and quality? If yes, describe

_____

_____

40. Do you have any other comments regarding the value chain of aquafeed industry in Egypt?

_____

_____

Appendix 2. Fish farmers' questionnaire

General information:

1. Location (Governorate-district-county):

_____

_____

2. Ownership (public, private (owned, rented), cooperatives, others)?:

_____

_____

3. Are you the owner of the farm-the manager-both?:

_____

_____

4. When did you start business?

_____

_____

5. Do you practice other professions/activities in addition to fish farming?: ( ) yes ( ) No

Technical Information

6. Farm type and farming systems

Farm type	( ) Earthen pond ( ) Concrete tanks ( ) Cages ( ) Others Specify _____			
Farm area (feddan)				
Farming Systems	( ) Extensive ( ) Semi-intensive ( ) Intensive: ( ) Others. Specify _____			
Type of water	( ) Fresh water ( ) Brackish water ( ) Marine ( ) Other			
Culture practices:				
( ) Monoculture	- Species and sexes (if monosex is used) _____ - Stocking size (gm) _____ - Stocking number/feddan _____ - Culture period (months) _____			
Polyculture ( )	Species	Stocking no./ feddan	Stocking size (g/fish)	Culture period (month)
	Tilapia			
	Mullet (specify) ( ) _____			
	Carps (specify) ( ) _____			
	Others (specify) ( ) _____			
( ) Integrated culture	Specify _____			
( ) Other practices	Specify _____			

7. Fertilizers and fertilization:

a- Organic fertilizers:	
Type of fertilizer/ manure: Specify	
Price (e.g. EGP/t)	
Change in prices compared to previous years	( ) Decreased ( ) Increased ( ) Stable
Transportation cost (EGP/t, EGP/truck, etc.)	
Storage (Specify where and how you store fertilizer)	
Availability and seasonality of fertilizer	
Availability compared to previous years	( ) Decreased ( ) Increased ( ) stable
Fertilization regime. Specify, including fertilization rates (t/feddan), frequency, methods of application, etc.,	
b- Inorganic fertilizers:	
Type of fertilizer	
Price (e.g. EGP/t)	
Change in prices compared to previous years	( ) Decreased ( ) Increased ( ) stable
Transportation cost (EGP/t, EGP/truck, etc)	
Storage (Specify where and how you store fertilizer)	
Availability and seasonality of fertilizer	
Availability compared to previous years	( ) Decreased ( ) Increased ( ) stable
Fertilization regime. Specify, including fertilization rates (t/feddan), frequency, methods of application, etc.,	

8. Supplemental/commercial feeds:

a. Do you use commercial fish feeds?
( ) Yes ( ) No

b. If yes, what type of feed?
( ) Extruded ( ) pressed ( ) Both ( ) farm-made

c. Where did you buy your feed from?
( ) directly from the feed mill ( ) from wholesalers ( ) from retailers
( ) Other sources (describe) _____

d. How do you buy your feed?
( ) Cash ( ) Loan ( ) other (specify) _____

e. Do you buy your feed ingredient, prepare your formula and rent feed mill to produce your feed? If yes, why do you apply this approach? Does this method lead to reducing feed cost? How much reduction compared to buying from feed producers _____

f. How do you pay the cost of your feeds? ( ) Cash ( ) Loans ( ) Credit ( ) other specify _____

g. How much feed did you use in 2012? and what are the average prices of the feed? (fill the table)

Type of feed	Extruded feed consumed in 2012		pressed feed consumed in 2012	
	Amount consumed (t)	Price (EGP/t)	Amount consumed (t)	Price (EGP/t)
25% CP				
30% CP				
35% CP				
40% CP				
others				
Total				

H. Changes in feed prices and availability?

Feed price compared to previous years	( ) Increased ( ) Decreased ( ) Stable
Feed availability and seasonality:	
Specify whether the feed is available continuously or if it faces seasonal fluctuation?	
Transportation cost (EGP/t)	
Transportation problems	
Storage: Specify where and how you store the feed	
% of feed cost to total operating costs	

9. Farm-made feed in 2012:

Do you produce fish feed on-farm?	( ) Yes ( ) No
If yes, How do you make the feed? Specify what ingredients you use, processing (drying, grinding, cooking, etc.)	
Do you use any additives?	( ) Yes ( ) No
If yes, which additives?	
What was the prices of additives in 2012 in EGP/kg	
What is the price of farm-made feed (EGP/t)	
% of farm-made feed cost to total operating costs	

10. Feed conversion ratio (FCR)

Feed type	25% CP	30% CP	35% CP	40% CP	>40 CP	Total average
Extruded feed:						
Larval feeds						
Fingerling/juvenile feeds						
Fattening feeds						
Pressed feeds:						
Larval feeds						
Fingerling/juvenile feeds						
Fattening feeds						
Farm-made feed:						
Larval feeds						
Fingerling/juvenile feeds						
Fattening feeds						

11. What are the major critical factors impacting on the inputs of fish feed and feed management?

Input being used	Problem experienced/ expected	Why does this problem occur?	What do you think this problem could be solved
Feed prices			
Feed quality			
Feed availability			
Feed storage			
Feed transport and delivery			
Others (specify) _____			

Other questions

12. Do you experience fish health problems/diseases related to feed?, if yes, what problems, how often and what is the scale or impact on farm income? _____

13. What is the feeding method do you apply? ( ) Manual ( ) Demand feeder ( ) Others

14. How do you get your seeds? ( ) Own hatchery ( ) Buy from producers.

15. In case of buying fish seeds, what are the major problems you face in terms of price, quality and availability?

16. How do you transport feeds from feed mills/traders to your farm?
( ) mill's vehicle ( ) my own vehicle ( ) rented vehicle ( ) Other (specify_____)

17. Do you receive any governmental subsidies? If yes, describe

_____

_____

18. What is the average harvest size and price (EGP/kg) in 2012?

_____

_____

_____

19. Do you receive any governmental extension support regarding feed and feeding practices? And capacity-building? If yes, describe the type of service, and how often

_____

_____

_____

20. Do you receive any support from non-governmental organizations (e.g. fish farmers associations), regarding training on aquafeed production, fish nutrition and feeding, and on-farm feed production/management? If yes, please describe

_____

_____

_____

21. Do you need any specific training and capacity building programs? If yes, describe

_____

_____

_____

22. Do you perform regular proximate analyses (or other analyses) of the feeds and feed ingredients you buy? If yes, how often?

_____

_____

_____

23. What is the maximum shelf life of the feed in your farm?

_____

_____

_____

24. Do you have any other comments on fish feed and feeding management?

_____

_____

_____

This publication should be cited as:
El-Sayed, A. F.M. (2014). Value chain analysis of the Egyptian aquaculture feed industry. WorldFish, Penang, Malaysia. Project Report: 2014-22.

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